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Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

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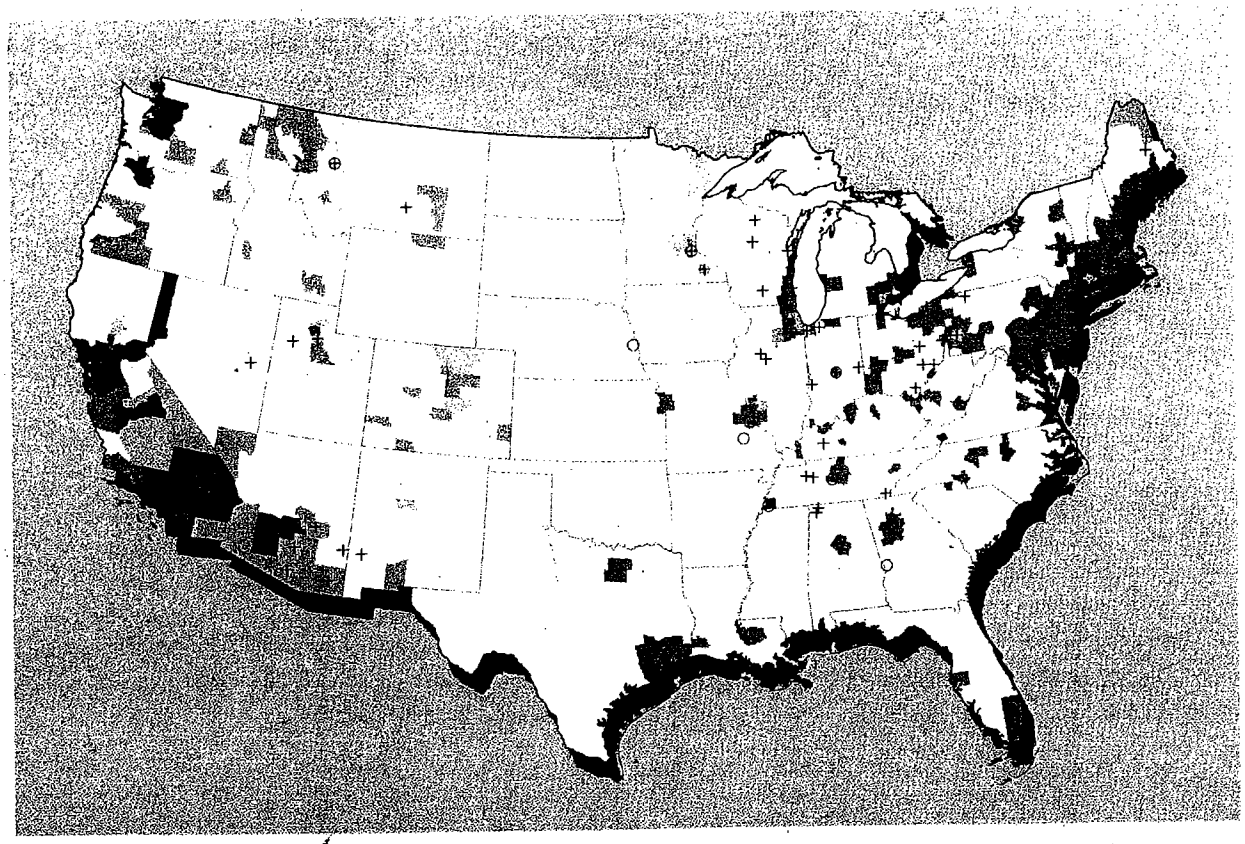
November 1991

AIR

EPA

National Air Quality and Emissions Trends Report, 1990



Counties with Non-Attainment Areas

EPA-450/4-91-023

National Air Quality and Emissions Trends Report, 1990

Technical Support Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711
November 1991

DISCLAIMER

This report has been reviewed by the Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, and has been approved for publication. Mention of trade names or commercial products is not intended to constitute endorsement or recommendation for use.

About the Cover: The map displays those counties within the contiguous U.S. that contain areas not meeting ozone, carbon monoxide and/or particulate matter National Ambient Air Quality Standards (NAAQS). See Section 4 for information on these areas.

PREFACE

This is the eighteenth annual report of air pollution trends issued by the U. S. Environmental Protection Agency. The report is prepared by the Technical Support Division and is directed toward both the technical air pollution audience and the interested general public. The Division solicits comments on this report and welcomes suggestions on our trend techniques, interpretations, conclusions, and methods of presentation. Please forward any response to Dr. Thomas C. Curran, (MD-14) U. S. Environmental Protection Agency, Technical Support Division, Research Triangle Park, North Carolina 27711.

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1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

This is the eighteenth annual report[1-17] documenting air pollution trends in the United States for those pollutants for which the U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS). EPA set these standards to protect public health and welfare. There are two types of NAAQS, primary and secondary. Primary standards are designed to protect public health, while secondary standards protect public welfare, such as effects of air pollution on vegetation, materials and visibility.

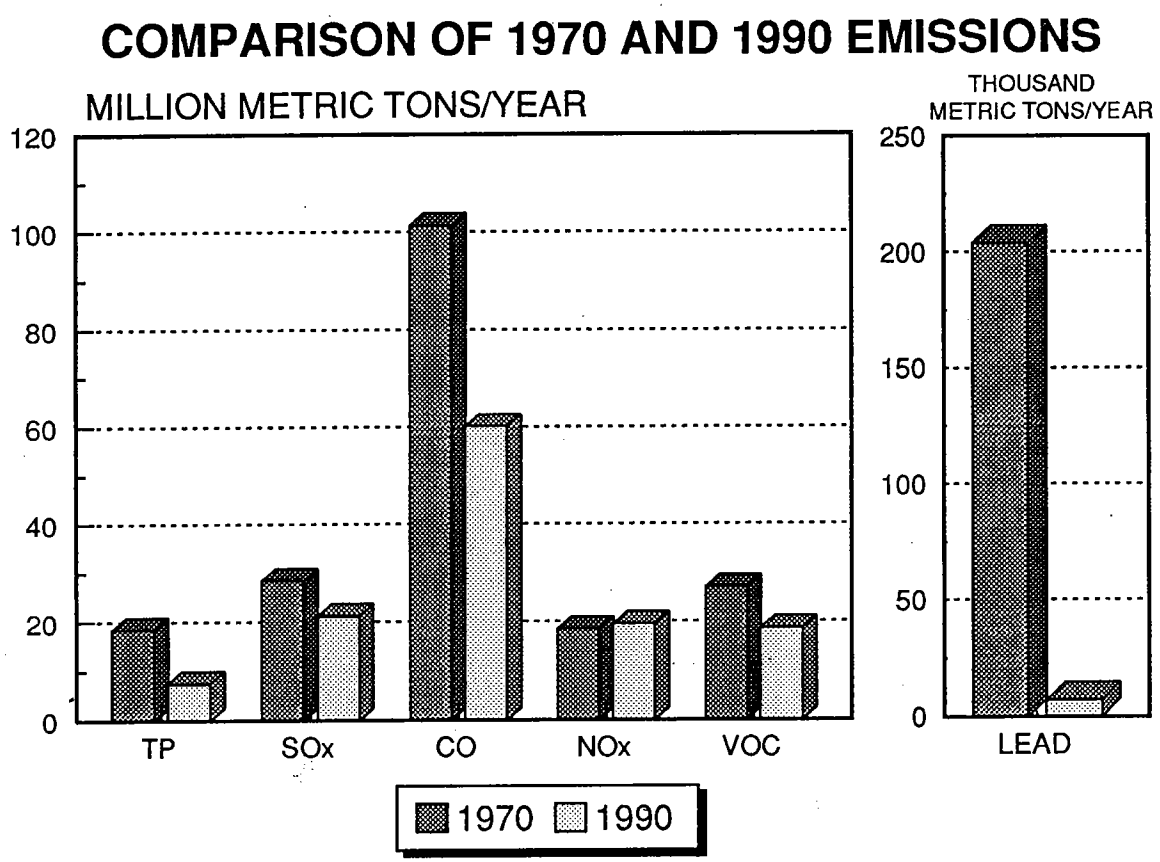
This report focuses on comparisons with the primary standards in effect in 1990 to examine changes in air pollution levels over time, and to summarize current air pollution status. There are six pollutants that have NAAQS: particulate matter (formerly as total suspended particulate (TSP) and now as PM-10 which emphasizes the smaller particles), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3) and lead (Pb). It is important to note that the discussions of ozone in this report refer to ground level, or tropospheric, ozone and not to stratospheric ozone. Ozone in the stratosphere, miles above the earth, is a beneficial screen from the sun's ultraviolet rays. Ozone at ground level, in the air we breathe, is a health and environmental concern and is the primary ingredient of what is commonly called smog.

The report tracks two kinds of trends: **air concentrations**, based on actual direct measurements of pollutant concentrations at selected sites throughout the country; and **emissions**, which are based upon the best available engineering calculations. It also provides estimates of the total tonnage of these pollutants released into the air annually. Chapter 4 of this report includes a detailed listing of selected 1990 air quality summary statistics for every metropolitan statistical area (MSA) in the nation and maps highlighting the largest MSAs. Chapter 5 presents 1981-90 trends for 15 cities and includes maps highlighting the locations of the monitoring networks.

A landmark event for air pollution control in the United States occurred in November 1990, with the passage of the Clean Air Act Amendments. While it is much too early for this Act to have influenced air pollution trends, some provisions are discussed briefly in this report because of the major role that the Act will play in dictating future air quality and emission trends in the U.S.

1.2 SOME PERSPECTIVE

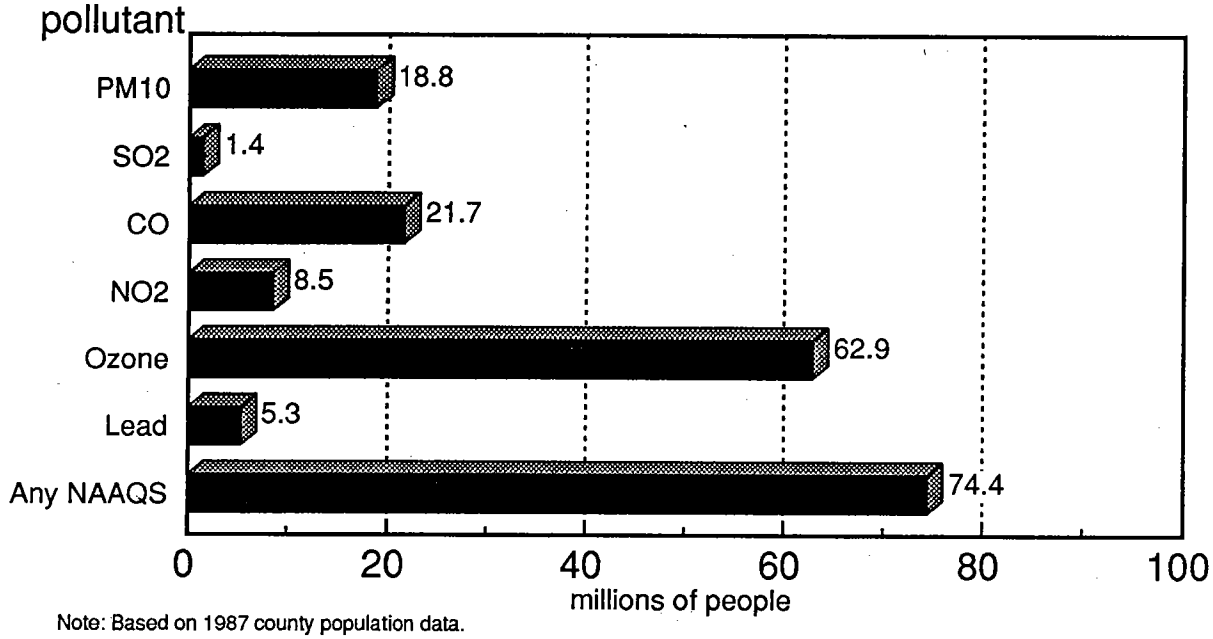
A 10-year time period is convenient for considering ambient air pollution trends because monitoring networks underwent many changes around 1980. However, it is important not to overlook some of the earlier control efforts in the air pollution field. Emission estimates are useful in examining longer term trends. Between 1970 and 1990, lead clearly shows the most impressive decrease (-97 percent) but improvements are also seen for total particulate (-59 percent), sulfur oxides (-25 percent), carbon monoxide (-41 percent), and volatile organic compounds (-31 percent). Only nitrogen oxides did not show improvement with emissions estimated to have increased 6 percent, due primarily to increased fuel combustion by stationary sources and motor vehicles. It is also important to realize that many of these reductions occurred even in the face of growth of emissions sources. More detailed information is contained in a companion report.[18]



While it is important to recognize that progress has been made, it is also important not to lose sight of the magnitude of the air pollution problem that still remains. About 74 million people in the U.S. reside in counties which did not meet at least one air quality standard based upon data for 1990. The 63 million people living in counties that exceeded the ozone standard in 1990 is 4 million fewer than in 1989. The 1990 estimates for carbon monoxide and PM-10 are substantially lower than population totals for 1989. These statistics, and associated qualifiers and limitations, are discussed in Chapter 4. These population estimates are based only upon a single year of data, 1990, and only consider counties with monitoring

data for that pollutant. As noted in Chapter 4, there are other approaches that would yield different numbers. For example, it is estimated that 140 million people live in ozone nonattainment areas based upon EPA's October 1991 designations. This is because ozone nonattainment decisions are based upon three years of data, rather than just one, to reflect a broader range of meteorological conditions. Also, nonattainment boundaries may consider other air quality related information, such as emission inventories and modeling, and may extend beyond those counties with monitoring data to more fully characterize the ozone problem and to facilitate the development of an adequate control strategy.

People in counties with 1990 air quality above primary National Ambient Air Quality Standards



Note: Based on 1987 county population data.

Finally, it should be recognized that this report focuses on those six pollutants that have National Ambient Air Quality Standards. There are other pollutants of concern. According to industry estimates, more than 2.4 billion pounds of toxic pollutants were emitted into the atmosphere in 1988. They are chemicals known or suspected of causing cancer or other serious health effects (e.g. reproductive effects). Control programs for the NAAQS pollutants can be expected to reduce these air toxic emissions by controlling particulates, volatile organic compounds and nitrogen oxides. However, Title III of the Clean Air Act Amendments of 1990 provided specific new tools to address routine and accidental releases of these pollutants. The statute established an initial list of 190 hazardous air pollutants. Using this list, EPA will publish a list of the source categories for which emission standards will be developed. EPA will issue standards for each listed source category, requiring the maximum degree of emissions reduction that has been demonstrated to be achievable. These are commonly referred to as maximum achievable control technology (MACT) standards. The Act also includes programs to help prevent the accidental release of hazardous chemicals.

1.3 MAJOR FINDINGS

PARTICULATE MATTER

AIR CONCENTRATIONS : Total Suspended Particulates (TSP) and PM-10

1982-90*: 3 percent decrease **TSP** (based on geometric mean at 1265 sites)
* 1981 data affected by a change in filters

1989-90: 3 percent decrease **TSP** (based on geometric mean at 734 sites)
8 percent decrease **PM-10** (based on arithmetic mean at 339 sites)

EMISSIONS : Total Particulates (TP) and PM-10

1981-90: 6 percent decrease **(TP)**
(Note: 9-year 1982-90 change was 6 percent increase)

1989-90: 4 percent increase **(TP)**; 5 percent increase **(PM-10)**

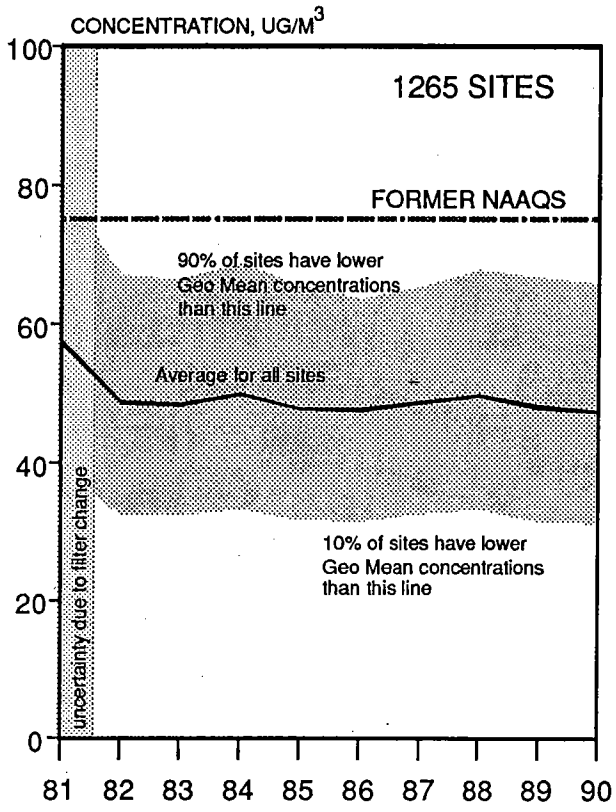
OVERVIEW

Trends TP emissions from historically inventoried sources have been reduced 59 percent since 1970. During the 1980's, TSP air quality levels improved 3 percent. In 1987, EPA replaced the earlier TSP standard with a PM-10 standard. (PM-10 focuses on the smaller particles likely to be responsible for adverse health effects because of their ability to reach the lower regions of the respiratory tract.) Ambient monitoring networks have recently been revised to measure PM-10 rather than TSP. Although PM-10 trends data are limited, ambient levels decreased 11 percent between 1988 and 1990. The PM-10 portion of TP emissions is estimated to have increased 7 percent since 1985 due to increases from transportation sources and forest fires. Nationally, fugitive sources provide 6-8 times more tonnage of PM-10 emissions than historically inventoried sources.

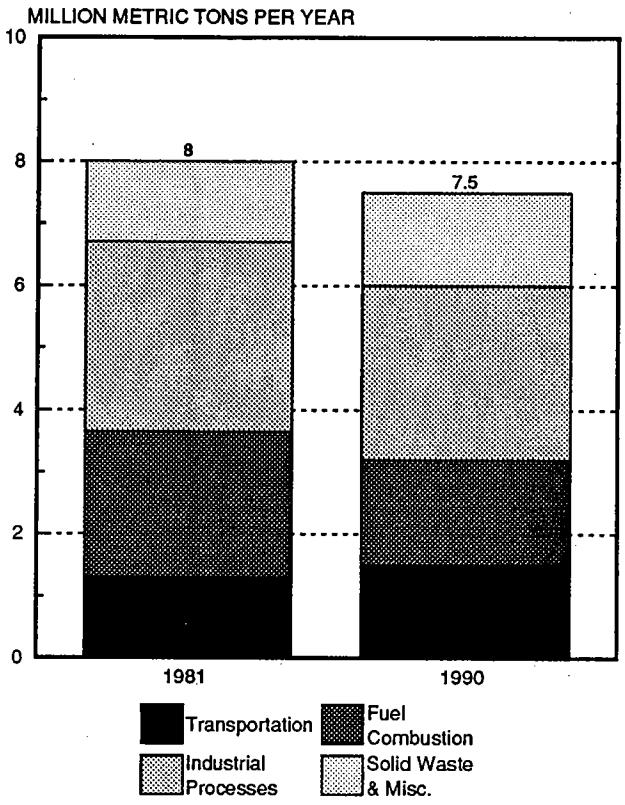
Status In October 1991, EPA designated 70 areas as nonattainment for PM-10. National average TSP levels in 1990 were the lowest of the past decade. Comparing 1989 and 1990, most of the country experienced an increase in precipitation and a decrease in TSP and PM-10.

1990 Clean Air Act The Act focuses attention on nonattainment of PM-10 health based standards. The Acid Rain provisions of the Act address visibility impairment caused by fine (<2.5 micrometer) particles.

TSP TREND, 1981-1990
(ANNUAL GEOMETRIC MEAN)



TP EMISSIONS TREND
(1981 vs. 1990)



PM EFFECTS

Based on studies of human populations exposed to high concentrations of particles (often in the presence of sulfur dioxide), and laboratory studies of animals and humans, the major effects of concern for human health include effects on breathing and respiratory symptoms, aggravation of existing respiratory and cardiovascular disease, alterations in the body's defense systems against foreign materials, damage to lung tissue, carcinogenesis and premature mortality. The major subgroups of the population that appear likely to be most sensitive to the effects of particulate matter include individuals with chronic obstructive pulmonary or cardiovascular disease, individuals with influenza, asthmatics, the elderly and children. Particulate matter causes damage to materials, soiling and is a major cause of substantial visibility impairment in many parts of the U.S.

SULFUR DIOXIDE (SO_2)

AIR CONCENTRATIONS

1981-90: 24 percent decrease (arithmetic mean at 457 sites)
30 percent decrease (24-hour second high at 452 sites)
87 percent decrease (24-hour exceedances at 452 sites)

1989-90: 7 percent decrease (arithmetic mean at 552 sites)

EMISSIONS : SO_x

1981-90: 6 percent decrease

1989-90: 2 percent increase

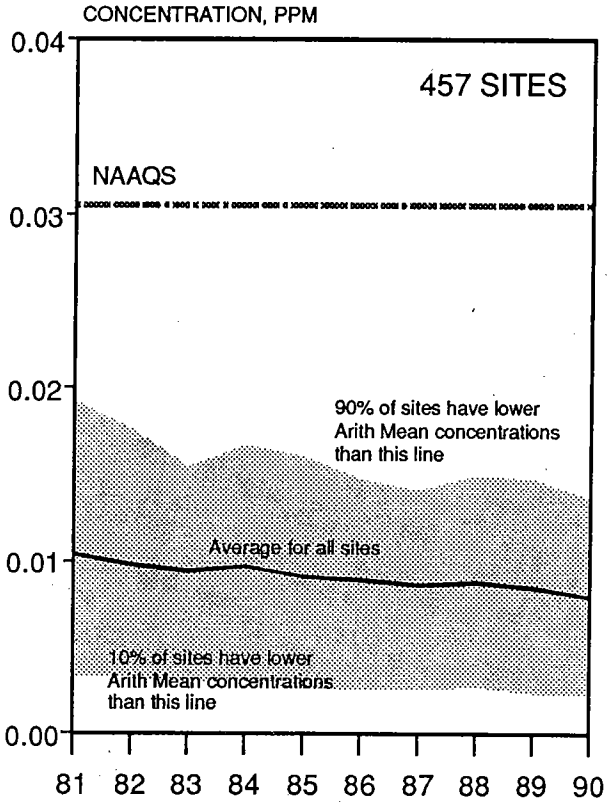
OVERVIEW

Trends SO_x emissions decreased 25 percent since 1970. During the 1980's, emissions improved 6 percent while average air quality improved by 24 percent. This difference occurs because the historical ambient monitoring networks were population-oriented while the major emission sources tend to be in less populated areas. The exceedance trend is dominated by source oriented sites. The 1981-90 decrease in emissions reflects reductions at coal-fired power plants. The 1989-90 emissions increase is due to increases from fuel combustion.

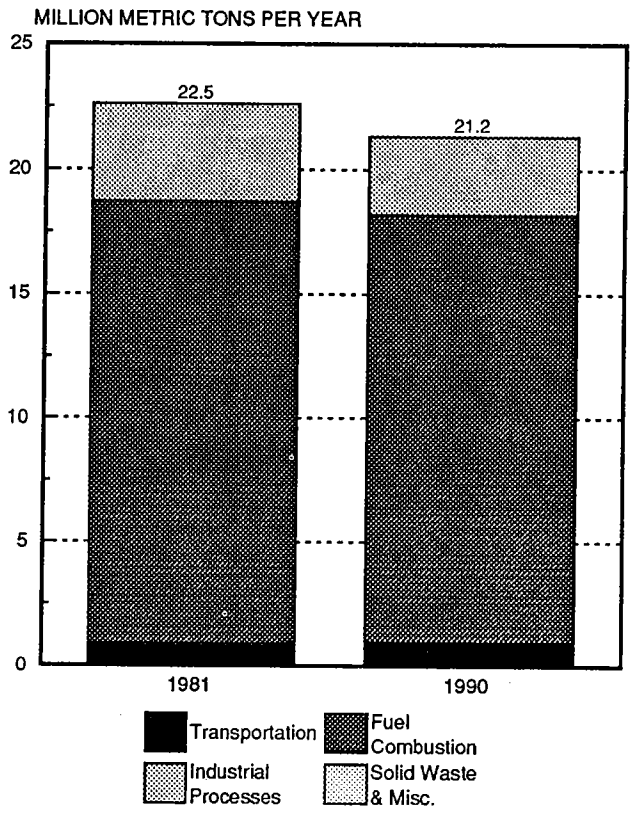
Status Almost all monitors in U.S. urban areas meet EPA's ambient SO_2 standards. Dispersion models are commonly used to assess ambient SO_2 problems around point sources because it is frequently impractical to operate enough monitors to provide a complete air quality assessment. Currently, there are 50 areas designated nonattainment for SO_2. Current concerns focus on major emitters, total atmospheric loadings and the possible need for a shorter-term (i.e. 1-hour) standard. Seventy percent of all national SO_x emissions are generated by electric utilities (92% of which come from coal fired power plants).

1990 Clean Air Act The Acid Rain provisions include a goal of reducing SO_x emissions by 10 million tons relative to 1980 levels. The focus in this control program is innovative market-based emission allowances which will provide affected sources flexibility in meeting the mandated emission reductions. This is EPA's first large-scale regulatory use of market-based incentives. These reductions will improve visibility in the East by substantially reducing SO_x emissions. These emissions are transformed into fine acid sulfate aerosol, the main cause of regional visibility impairment.

SO2 TREND, 1981-1990
(ANNUAL ARITHMETIC MEAN)



SOX EMISSIONS TREND
(1981 vs. 1990)



SO_2 EFFECTS

The major health effects of concern associated with high exposures to sulfur dioxide include effects on breathing, respiratory illness and symptoms, alterations in the lung's defenses, aggravation of existing respiratory and cardiovascular disease, and mortality. The major subgroups of the population most sensitive to sulfur dioxide include asthmatics and individuals with chronic lung disease (such as bronchitis or emphysema) or cardiovascular disease. Children and the elderly may also be sensitive. Sulfur dioxide produces foliar damage on trees and agricultural crops. It and nitrogen oxides are major precursors to acidic deposition (acid rain), which is associated with a number of effects including acidification of lakes and streams, accelerated corrosion of buildings and monuments and visibility impairment.

CARBON MONOXIDE (CO)

AIR CONCENTRATIONS

1981-90: 29 percent decrease (8-hour second high at 301 sites)
87 percent decrease (8-hour exceedances at 301 sites)

1989-90: 8 percent decrease (8-hour second high at 359 sites)

EMISSIONS

1981-90: 22 percent decrease

1989-90: less than 1 percent decrease

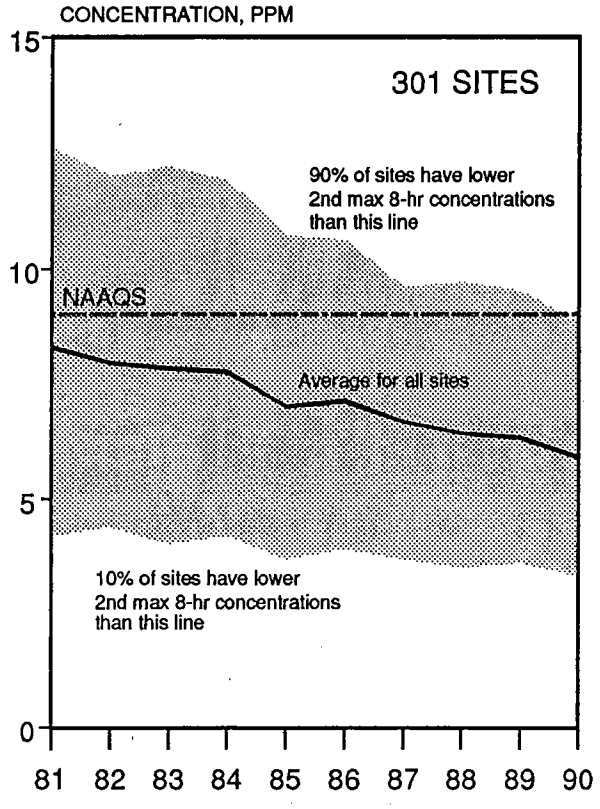
OVERVIEW

Trends Carbon monoxide emissions decreased 41 percent since 1970. Progress continued through the 1980's with 29 percent improvement in air quality levels and a 22 percent reduction in total emissions. This progress occurred despite continued growth in miles of travel in the U.S. Transportation sources account for approximately two-thirds of the nation's CO emissions. Emissions from highway vehicles decreased 37 percent during the 1981-90 period, despite a 37 percent increase in vehicle miles of travel. Estimated nationwide CO emissions decreased less than 1 percent between 1989 and 1990, with forest fire activity in 1990 offsetting the 7 percent decrease in CO emissions from highway vehicles.

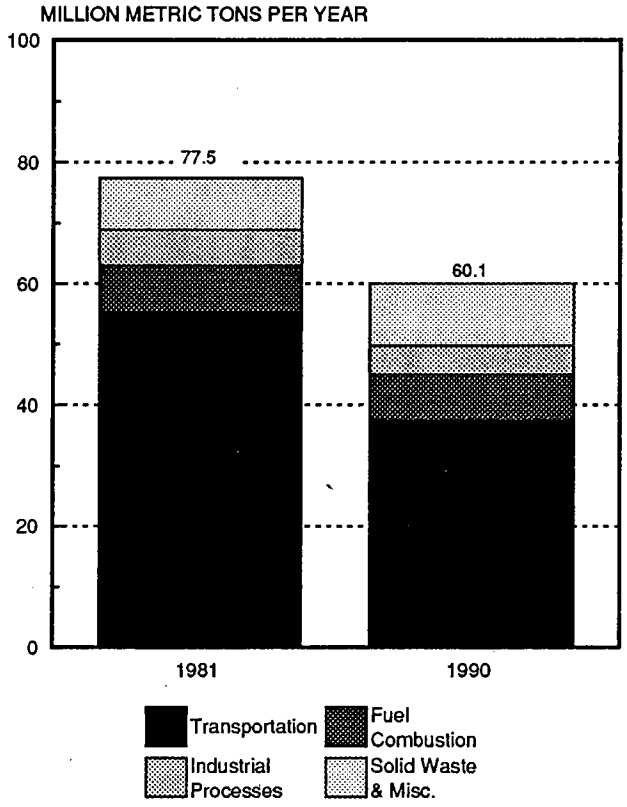
Status In October 1991, EPA designated 42 areas as nonattainment for CO.

1990 Clean Air Act The remaining CO nonattainment areas have specific planning and implementation requirements specified in Title I of the Act that vary depending upon the magnitude of the CO problem. In addition, Title II of the Act, which deals with mobile sources, includes a variety of provisions to help reduce CO levels including a winter time oxygenated fuels program for CO nonattainment areas, increased application of vehicle inspection and maintenance programs, and a tailpipe standard for CO under cold temperature conditions.

CO TREND, 1981-1990
(ANNUAL 2ND MAX 8-HR AVG)



CO EMISSIONS TREND
(1981 vs. 1990)



CO EFFECTS

Carbon monoxide enters the bloodstream and reduces the delivery of oxygen to the body's organs and tissues. The health threat from carbon monoxide is most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease. Healthy individuals also are affected but only at higher levels. Exposure to elevated carbon monoxide levels is associated with impairment of visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks.

NITROGEN DIOXIDE (NO_2)

AIR CONCENTRATIONS

1981-90: 8 percent decrease (annual mean at 166 sites)

1989-90: 6 percent decrease (annual mean at 211 sites)

EMISSIONS : NO_x

1981-90: 6 percent decrease

1989-90: 1 percent decrease

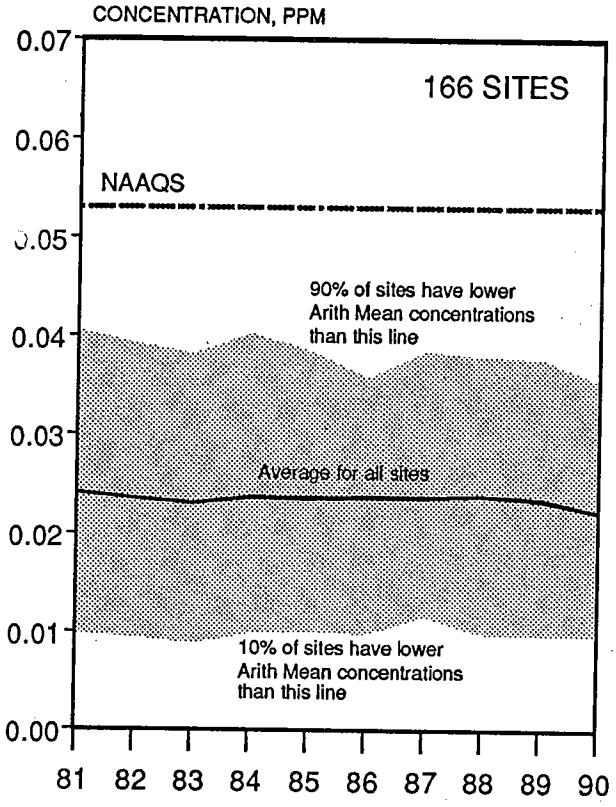
OVERVIEW

Trends Nitrogen oxide emissions increased 6 percent since 1970 but both emissions (-6 percent) and nitrogen dioxide air quality (-8 percent) showed improvement during the 1980's. The national trend in annual mean NO_2 concentrations was flat for most of the 1980's, however, annual mean NO_2 levels have declined during the past two years. The two primary source categories of nitrogen oxide emissions, and their contribution in 1990, are fuel combustion (57 percent) and transportation (38 percent). The transportation category has decreased 24 percent while fuel combustion emissions are estimated to have increased by 12 percent.

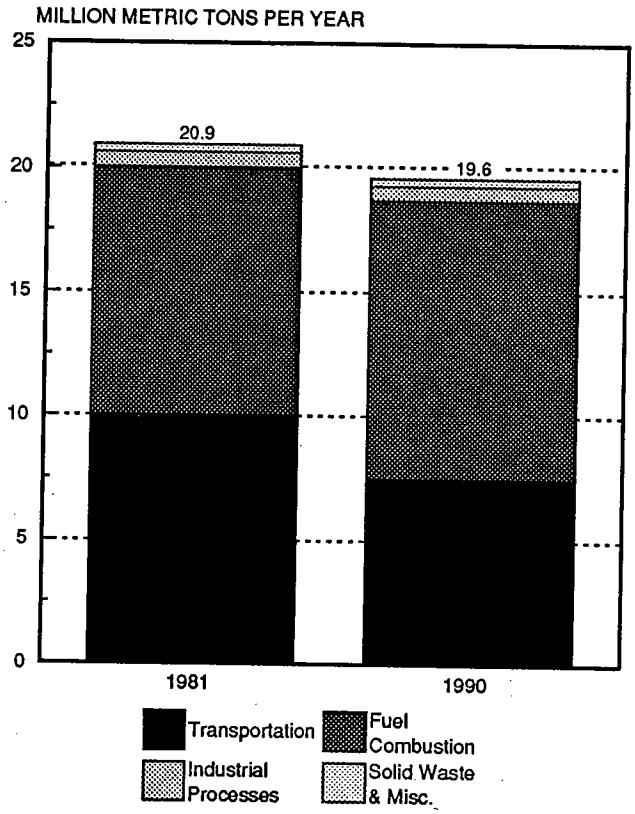
Status In October 1991, EPA designated only one area as nonattainment for NO_2. Los Angeles, CA, which reported an annual mean of 0.056 ppm in 1990, is the only urban area that has recorded violations of the annual NO_2 NAAQS of 0.053 ppm during the past 10 years.

1990 Clean Air Act Although Los Angeles is the only nonattainment area for nitrogen dioxide, the Clean Air Act Amendments of 1990 recognized the need for nitrogen oxide controls due to its contributing role in other problems including ozone (smog) and acid rain. EPA has already issued final tighter tailpipe standards for NO_x as required under the new amendments. Future ozone (smog) control plans will address further NO_x controls and the Acid Rain provisions of the Act calls for a 2 million ton NO_x reduction from affected utilities.

NO2 TREND, 1981-1990
(ANNUAL ARITHMETIC MEAN)



NOX EMISSIONS TREND
(1981 vs. 1990)



NO_2 EFFECTS

Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infection (such as influenza). The effects of short-term exposure are still unclear but continued or frequent exposure to concentrations higher than those normally found in the ambient air may cause increased incidence of acute respiratory disease in children. Nitrogen oxides are an important precursor both to ozone and to acidic precipitation and may affect both terrestrial and aquatic ecosystems. Atmospheric deposition of NO_x is a potentially significant contributor to ecosystem effects including algal blooms in certain estuaries such as the Chesapeake Bay. In some western areas, NO_x is an important precursor to PM-10 concentrations.

OZONE (O_3)

AIR CONCENTRATIONS

1981-90: 10 percent decrease (second highest daily max 1-hour at 471 sites)
51 percent decrease (exceedance days at 471 sites)
1989-90: 1 percent decrease (second highest daily max 1-hour at 590 sites)

EMISSIONS : VOC

1981-90: 12 percent decrease
1989-90: 1 percent increase

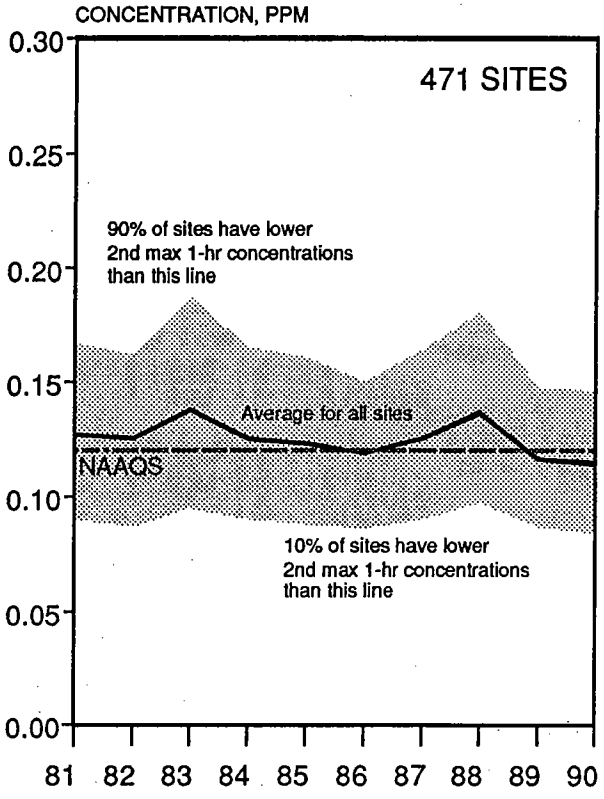
OVERVIEW

Trends Ground level ozone, the primary constituent of smog, has been a pervasive pollution problem for the U.S. Ambient trends during the 1980's were influenced by varying meteorological conditions. Relatively high 1983 and 1988 ozone levels are likely attributed in part to hot, dry, stagnant conditions in some areas of the country. Both 1989 and 1990 levels showed improvement but the complexity of the ozone problem warrants caution in interpreting the data. There have been recent control measures, such as lower Reid Vapor Pressure (RVP) for gasoline resulting in lower fuel volatility and lower NO_x and VOC emissions from tailpipes. Emission estimates for volatile organic compounds (VOCs), which contribute to ozone formation, are estimated to have improved by 31 percent since 1970 and 12 percent since 1981. However, these volatile organic compound (VOC) emission estimates represent annual totals. NO_x emissions, the other major precursor factor in ozone formation, decreased 6 percent between 1981 and 1990. While these annual emission totals are the best national numbers now available, ozone is predominantly a warm weather problem and seasonal emission trends would be preferable.

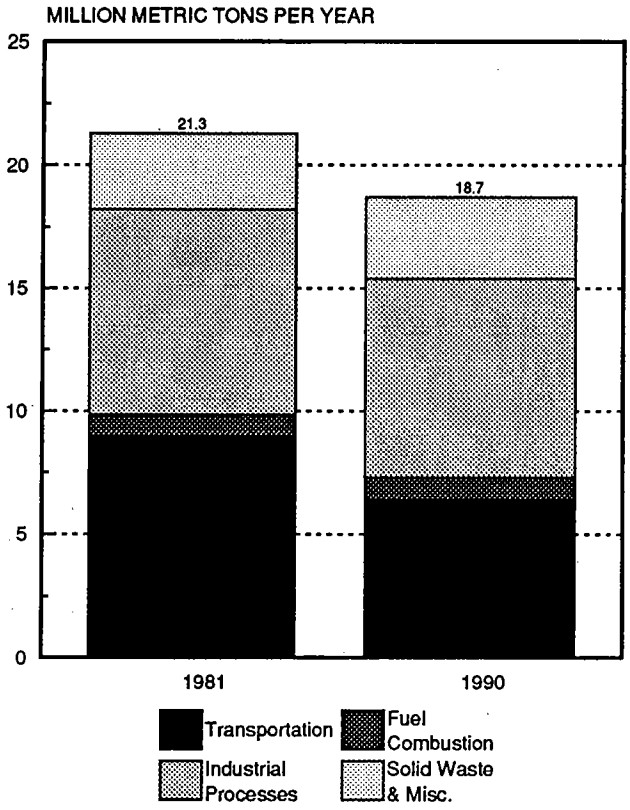
Status In October 1991, EPA designated 98 areas as nonattainment for O_3.

1990 Clean Air Act The Act expanded the framework for designating areas as attainment or nonattainment for ozone by further classifying areas based upon the magnitude of their problem. Ozone nonattainment areas are now classified as marginal, moderate, serious, severe or extreme. This allows more flexibility in the required control program. The Act includes a variety of new requirements for cars and other sources of ozone precursors, including the introduction of cleaner (reformulated) gasoline beginning in 1995 into the nine U.S. cities with the worst ozone problems.

OZONE TREND, 1981-1990
(ANNUAL 2ND DAILY MAX HOUR)



VOC EMISSIONS TREND
(1981 vs. 1990)



O_3 EFFECTS

The reactivity of ozone causes health problems because it damages biological tissues and cells. Recent scientific evidence indicates that ambient levels of ozone not only affect people with impaired respiratory systems, such as asthmatics, but healthy adults and children, as well. Exposure to ozone for 6 - 7 hours at relatively low concentrations (i.e. 0.08 ppm) has been found to significantly reduce lung function in normal, healthy people during periods of moderate exercise. This decrease in lung function often is accompanied by such symptoms as chest pain, coughing, nausea and pulmonary congestion. Though less well established in humans, animal studies have demonstrated that repeated exposure to ozone for months to years can produce permanent structural damage in the lungs and accelerate the rate of lung function loss and aging of the lungs. Ozone is responsible each year for agricultural crop yield loss in the U.S. of several billion dollars and causes noticeable foliar damage in many crops and species of trees. Forest and ecosystem studies indicate that damage is resulting from current ambient ozone levels.

LEAD (Pb)

AIR CONCENTRATIONS

1981-90: 85 percent decrease (maximum quarterly average at 202 sites)

1989-90: 12 percent decrease (maximum quarterly average at 229 sites)

EMISSIONS

1981-90: 87 percent decrease in total lead emissions
(95 percent decrease in lead emissions from transportation sources)

1989-90: 1 percent decrease in total lead emissions
(no change in lead emissions from transportation sources)

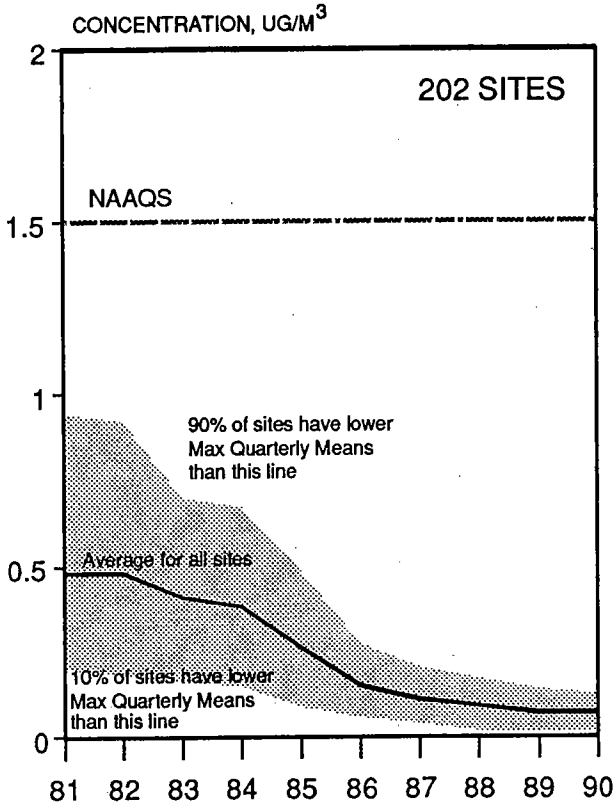
OVERVIEW

Trends Total lead emissions have dropped 97 percent since 1970 due principally to reductions in ambient lead levels from automotive sources. Ambient lead (Pb) concentrations in urban areas throughout the country have decreased 85 percent since 1981 while emissions decreased by 87 percent. The drop in Pb consumption and subsequent Pb emissions was brought about by the increased use of unleaded gasoline in catalyst-equipped cars (89 percent of the total gasoline market in 1990) and the reduced Pb content in leaded gasoline.

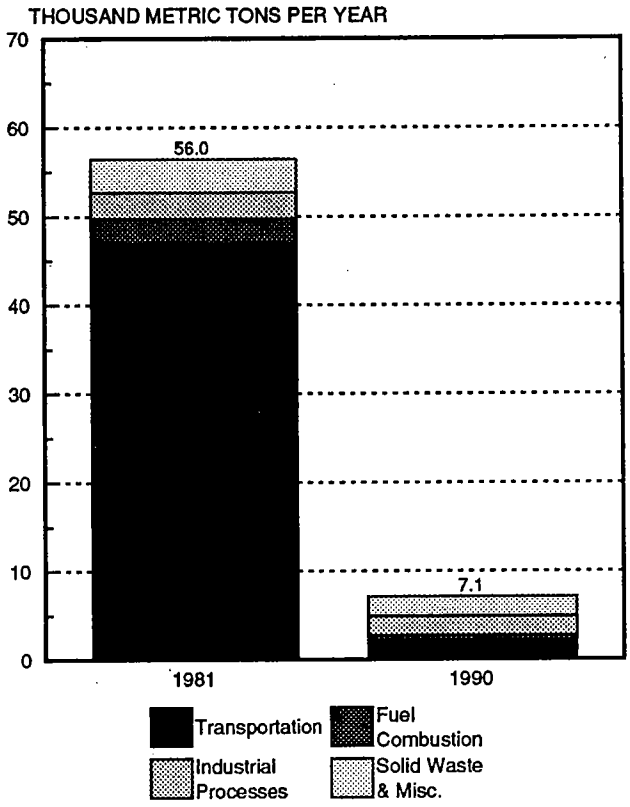
Status In 1990, the reduction of exposure to lead became a top priority objective for the Agency. Among other things, EPA identified 29 stationary sources with potential problems. An assessment of these sources' compliance status, ambient monitoring availability and State implementation plan (SIP) adequacy was completed.

1990 Clean Air Act The Amendments, for the first time, authorize EPA to designate areas nonattainment, attainment or unclassifiable for the lead NAAQS. As such, EPA has designated as nonattainment 12 areas which have recently recorded violations of the lead NAAQS. EPA has also designated as unclassifiable 9 areas for which existing air quality data are insufficient at this time to designate as either attainment or nonattainment. As States submit designation requests and as ambient monitoring data become available, EPA will proceed to designate additional lead areas as appropriate. Once an area is designated nonattainment for the lead NAAQS, States must submit revised pollution control plans within 18 months of the area's nonattainment designation.

PB TREND, 1981-1990
(ANNUAL MAX QUARTERLY AVG)



PB EMISSIONS TREND
(1981 vs. 1990)



PB EFFECTS

Exposure to lead can occur through multiple pathways, including inhalation of air, diet and ingestion of lead in food, water, soil or dust. Lead accumulates in the body in blood, bone and soft tissue. Because it is not readily excreted, lead also affects the kidneys, liver, nervous system and blood-forming organs. Excessive exposure to lead may cause neurological impairments such as seizures, mental retardation and/or behavioral disorders. Even at low doses, lead exposure is associated with changes in fundamental enzymatic, energy transfer and homeostatic mechanisms in the body. Fetuses, infants and children are especially susceptible to low doses of lead, often suffering central nervous system damage. Recent studies have also shown that lead may be a factor in high blood pressure and subsequent heart disease in middle-aged white males.

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2. INTRODUCTION

This report focuses on 10-year (1981-90) national air quality trends for each of the major pollutants for which National Ambient Air Quality Standards (NAAQS) have been established. This section presents many of the technical details involved in these analyses; readers familiar with previous reports may prefer initially to proceed directly to the remaining sections. The national analyses are complemented in Section 5 with air quality trends in 15 metropolitan areas for the period 1981 through 1990.

The national air quality trends are based on the results of actual air pollution measurements at air monitoring sites located throughout the U.S. The National Air Monitoring Station (NAMS) sites were established through monitoring regulations promulgated in May 1979[1]. The NAMS sites provide accurate and timely data to the U.S. Environmental Protection Agency (EPA) from a national air monitoring network. The NAMS are located in areas with higher pollutant concentrations and high population exposure. These stations meet uniform criteria for siting, quality assurance, equivalent analytical methodology, sampling intervals and instrument selection to assure consistent data reporting among the States. Other sites operated by the State and local air pollution control agencies, such as the State and Local Air Monitoring Stations (SLAMS) and Special Purpose Monitors (SPM), in general, also meet the same rigid criteria. However, in addition to being located in the area of highest concentration and high population exposure, these sites are located in other areas as well.

Air quality status may be determined by comparing the ambient air pollution levels with the appropriate primary and secondary NAAQS for each of the pollutants (Table 2-1). Primary standards protect the public health; secondary standards protect the public welfare as measured by effects of pollution on vegetation, materials and visibility. The standards are further categorized for different averaging times. Long-term standards specify an annual or quarterly mean that may not be exceeded; short-term standards specify upper limit values for 1-, 3-, 8- or 24-hour averages. Except for the pollutants ozone and PM-10, the short-term standards are not to be exceeded more than once per year. The ozone standard requires that the expected number of days per calendar year with daily maximum hourly concentrations exceeding 0.12 parts per million (ppm) be less than or equal to one. The 24-hour PM-10 standard also allows one expected exceedance per year.

Trends are also presented for annual nationwide emissions. These are estimates of the amount and kinds of pollution being emitted by automobiles, factories and other sources, based upon the best available engineering calculations for a given time period. Five source categories of direct emissions have been historically inventoried: tail pipe emissions from transportation sources, fuel combustion from powerplants and residential sources, other stationary sources resulting from industrial processes, solid waste and miscellaneous. The latter largely consists of emissions resulting from forest fires. The 1990 emission estimates are preliminary and may be revised in the next annual report. The emission trends are taken from the EPA publication, National Air Pollutant Emission Estimates, 1940-1990[2]. The reader is referred to this publication for more detailed information. For particulates, emission estimates are presented for both total particulates, without any distinction of particle sizes, as well as for PM-10, which refers to "inhalable" particles with aerodynamic diameter less that 10 microns. Trends in sources of fugitive dust emissions for PM-10 are included for 1985-1990. These fugitive emissions are estimated to amount to a considerable portion of particulate emissions. Fugitive sources surveyed include vehicular traffic on paved and unpaved roads, wind erosion, construction activity and agriculture tilling.

Section 4 of this report, "Air Quality Status of Metropolitan Areas, 1990", provides greatly simplified air pollution information. Air quality statistics are presented for each of the pollutants for all Metropolitan Statistical Areas (MSAs) reporting monitoring data to EPA for 1990.

TABLE 2-1. National Ambient Air Quality Standards (NAAQS) in Effect in 1990.

POLLUTANT	PRIMARY (HEALTH RELATED)		SECONDARY (WELFARE RELATED)	
	Averaging Time	Standard Level Concentration[a]	Averaging Time	Standard Level Concentration
PM-10	Annual Arithmetic Mean[b]	50 $\mu g/m^3$		Same as Primary
	24-hour[b]	150 $\mu g/m^3$		Same as Primary
SO_2	Annual Arithmetic Mean	(0.03 ppm) 80 $\mu g/m^3$	3-hour[c]	1300 $\mu g/m^3$ (0.50 ppm)
	24-hour[c]	(0.14 ppm) 365 $\mu g/m^3$		
CO	8-hour[c]	9 ppm (10 $\mu g/m^3$)		No Secondary Standard
	1-hour[c]	35 ppm (40 $\mu g/m^3$)		No Secondary Standard
NO_2	Annual Arithmetic Mean	0.053 ppm (100 $\mu g/m^3$)		Same as Primary
O_3	Maximum Daily 1-hour Average[d]	0.12 ppm (235 $\mu g/m^3$)		Same as Primary
Pb	Maximum Quarterly Average	1.5 $\mu g/m^3$		Same as Primary

[a] Parenthetical value is an approximately equivalent concentration.

[b] TSP was the indicator pollutant for the original particulate matter (PM) standards. This standard has been replaced with the new PM-10 standard and it is no longer in effect. New PM standards were promulgated in 1987, using PM-10 (particles less than 10μ in diameter) as the new indicator pollutant. The annual standard is attained when the expected annual arithmetic mean concentration is less than or equal to 50 $\mu g/m^3$; the 24-hour standard is attained when the expected number of days per calendar year above 150 $\mu g/m^3$ is equal to or less than 1; as determined according to Appendix K of the PM NAAQS.

[c] Not to be exceeded more than once per year.

[d] The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than 1, as determined according to Appendix H of the Ozone NAAQS.

2.1 AIR QUALITY DATA BASE

The ambient air quality data used in this report were obtained from EPA's Aerometric Information Retrieval System (AIRS). Air quality data are submitted to AIRS by both State and local governments, as well as federal agencies. Presently, there are about 500 million air pollution measurements on AIRS. The vast majority of these measurements represent the more heavily populated urban areas of the nation.

For a monitoring site to have been included in the national 10-year trend analysis, the site had to contain complete data for at least 8 of the 10 years 1981 to 1990. For the regional comparisons, the site had to report data in each of the last three years to be included in the analysis. Table 2-2 displays the number of sites meeting the completeness criteria for both data bases. For PM-10, whose monitoring network has just been initiated over the last few years, analyses are based on 339 sites with data in 1988 through 1990. Data for each year had to satisfy annual data completeness criteria appropriate to pollutant and measurement methodology. The air quality data are divided into two major groupings -- 24-hour measurements and continuous 1-hour measurements. The 24-hour measurements are obtained from monitoring instruments that produce one measurement per 24-hour period and are typically operated on a systematic sampling schedule of once every 6 days, or 61 samples per year. Such instruments are used to measure TSP, PM-10, SO_2, NO_2 and Pb. For PM-10, more frequent sampling of every other day or everyday is now also common. Data collected only as 24-hour measurements were not used in the SO_2 and NO_2 trends analyses because these methods have essentially been phased out of the monitoring network. Total suspended particulate and PM-10 data were judged adequate for trends analysis if there were at least 48 samples for the year. Both 24-hour and composite data were used in the Pb trends analyses. The 24-hour Pb data had to have at least six samples per quarter in at least 3 of the 4 calendar quarters. Monthly composite Pb data were used if at least two monthly samples were available for at least 3 of the 4 calendar quarters.

The 1-hour data are obtained from monitoring instruments that operate continuously, producing a measurement every hour for a possible total of 8760 hourly measurements in a year. For continuous hourly data, a valid annual mean for SO_2 and NO_2 trends requires at least 4380 hourly observations. This same annual data completeness, of at least 4380 hourly values, was required for the CO standard related statistics - the second maximum nonoverlapping 8-hour average and the estimated number of exceedances of the 8-hour average CO standard. A slightly different criterion was used for the SO_2 standard related daily statistics - the second daily maximum 24-hour average and the estimated number of daily exceedances of the SO_2 standard. Instead of requiring 4380 or more hourly values, 183 or more daily values were required. A valid day is defined as one consisting of at least 18 hourly observations. Because of the different selection criteria, the number of sites used to produce the daily SO_2 statistics is slightly different than the number of sites used to produce the annual SO_2 statistics.

Finally, because of the seasonal nature of ozone, both the second daily maximum 1-hour value and the estimated number of exceedances of the O_3 NAAQS were calculated for the ozone season, which typically varies by State.[3] For example, in California, the ozone season is defined as 12 months, January through December, while in New Jersey it is defined as 7 months, April through October. For a site to be included, at least 50 percent of the daily data had to be available for the ozone season.

The use of a moving 10-year window for trends yields a data base that is more consistent with the current monitoring network and reflects the period following promulgation of uniform monitoring requirements. In addition, this procedure increases the total number of trend sites (except for TSP) for the 10-year period relative to the data bases used in the last annual report.[4] As shown in Section 3, the size of the TSP monitoring network has been declining, especially since promulgation of the PM-10 standard.

TABLE 2-2. Number of Air Quality Trend Sites, 1981-90 and 1988-90.

POLLUTANT	NUMBER OF SITES REPORTING IN 1990	NUMBER OF TREND SITES 1981-90	1988-90
Total Suspended Particulate (TSP)	1,061	1,265	734
Particulate (PM-10)	1,279	N/A	339
Sulfur Dioxide (SO_2)	741	457	552
Carbon Monoxide (CO)	491	301	359
Nitrogen Dioxide (NO_2)	330	166	211
Ozone (O_3)	812	471	590
Lead (Pb)	406	202	229
TOTAL	5,120	2,862	3,014

2.2 TREND STATISTICS

The air quality analyses presented in this report comply with the recommendations of the Intra-Agency Task Force on Air Quality Indicators.[5] The air quality statistics used in these pollutant-specific trend analyses relate to the appropriate NAAQSs. Two types of standard-related statistics are used - peak statistics (the second maximum 24-hour SO_2 average, the second maximum nonoverlapping 8-hour CO average, and the second daily maximum 1-hour O_3 average) and long-term averages (the annual geometric mean for TSP, the annual arithmetic means for PM-10, SO_2 and NO_2, and the quarterly arithmetic mean for Pb). For the peak statistics, the second maximum value is used, because this is the value that traditionally has been used to determine whether or not a site has or has not met an air quality standard in a particular year. For PM-10, with its variable sampling frequency, the 90th percentile of 24-hour concentrations is used to examine changes in peak values. A composite average of each of these statistics is used in the graphical presentations that follow. All sites were weighted equally in calculating the composite average trend statistic. Missing annual summary statistics for the second through ninth years for a site are estimated by linear interpolation from the surrounding years. Missing end points are replaced with the nearest valid year of data. This procedure results in a statistically balanced data set to which simple statistical procedures and graphics can be applied. The procedure is also conservative, because end-point rates of change are dampened by the interpolated estimates.

This report presents statistical confidence intervals to facilitate a better understanding of measured changes in air quality. Confidence intervals are placed around composite averages, based on sites that satisfy annual data completeness requirements. The confidence intervals can be used to make comparisons between years; if the confidence intervals for any 2 years do not overlap, then the composite averages

of the 2 years are significantly different (Figure 2-1). Ninety-five percent confidence intervals for composite averages of annual means (arithmetic and geometric) and second maxima were calculated from a two-way analysis of variance followed by an application of the Tukey Studentized Range.[6] The confidence intervals for composite averages of estimated exceedances were calculated by fitting Poisson distributions[7] to the exceedances each year and then applying the Bonferroni multiple comparisons procedure.[8] The utilization of these procedures is explained in publications by Pollack, Hunt and Curran[9] and Pollack and Hunt.[10]

Boxplots[11] are used to present air quality trends because they have the advantage of displaying, simultaneously, several features of the data. Figure 2-2 illustrates the use of this technique in presenting the 5th, 10th, 25th, 50th (median), 75th, 90th and 95th percentiles of the data, as well as the composite average. The 5th, 10th and 25th percentiles depict the "cleaner" sites. The 75th, 90th and 95th depict the "higher" sites, and the median and average describe the "typical" sites. For example, 90 percent of the sites would have concentrations equal to or lower than the 90th percentile. Although the average and median both

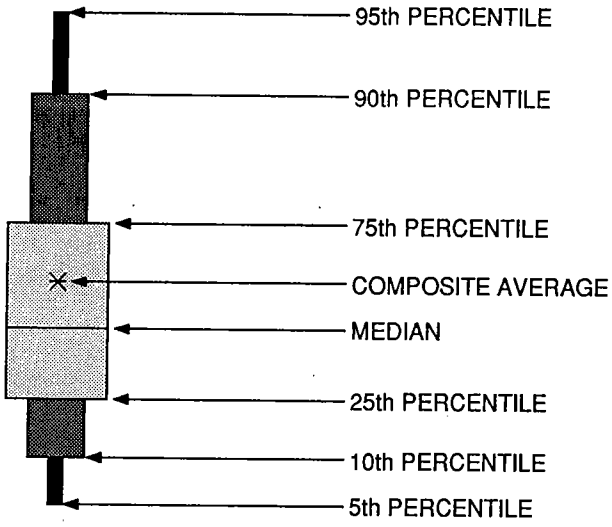

Figure 2-2. Illustration of plotting convention of boxplots.

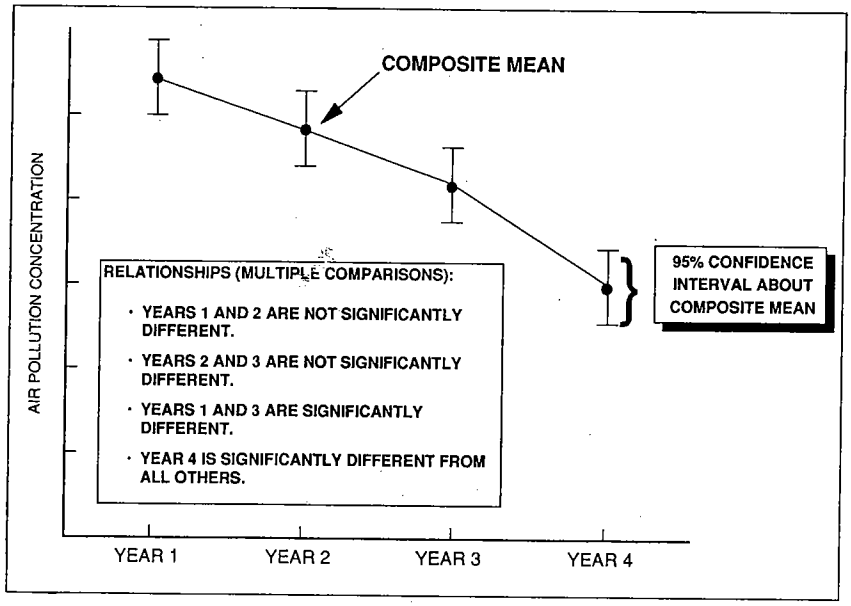

Figure 2-1. Sample illustration of use of confidence intervals to determine statistically significant change.

characterize typical behavior, the median has the advantage of not being affected by a few extremely high observations. The use of the boxplots allows us simultaneously to compare trends in the "cleaner", "typical" and "higher" sites.

Bar graphs are introduced for the Regional comparisons with the 3-year trend data base. These comparisons are based on the ten EPA Regions (Figure 2-3). The composite averages of the appropriate air quality statistic of the years 1988, 1989 and 1990 are presented. The approach is simple, and it allows the reader at a glance to compare the short-term changes in all ten EPA Regions.

In addition to concentration related statistics, other statistics are used, when appropriate, to clarify further the observed air quality trends. Particular attention is given to the estimated number of exceedances of the short-term NAAQSs. The estimated number of exceedances is the measured number of exceedances adjusted to account for incomplete sampling. Trends in exceedances tend to be more variable than in the other concentration related statistics, particularly on a percentage basis. For example, a site may show a 50 percent decrease in annual exceedances, from 2 to 1 per year, and yet record less than a 5 percent decrease in average concentration levels. The change in concentration levels is likely to be more indicative of changes in emission levels.

Trends are also presented for annual nationwide emissions. These emissions data are estimated using the best available engineering calculations. The emissions data are reported as teragrams (one million metric tons) emitted to the atmosphere per year, except for lead emissions, which are reported as gigagrams (one thousand metric tons).[2] These are estimates of the amount and kinds of pollution being generated by automobiles, factories and other sources. Estimates for earlier years are recomputed using current methodology so that these estimates are comparable over time.

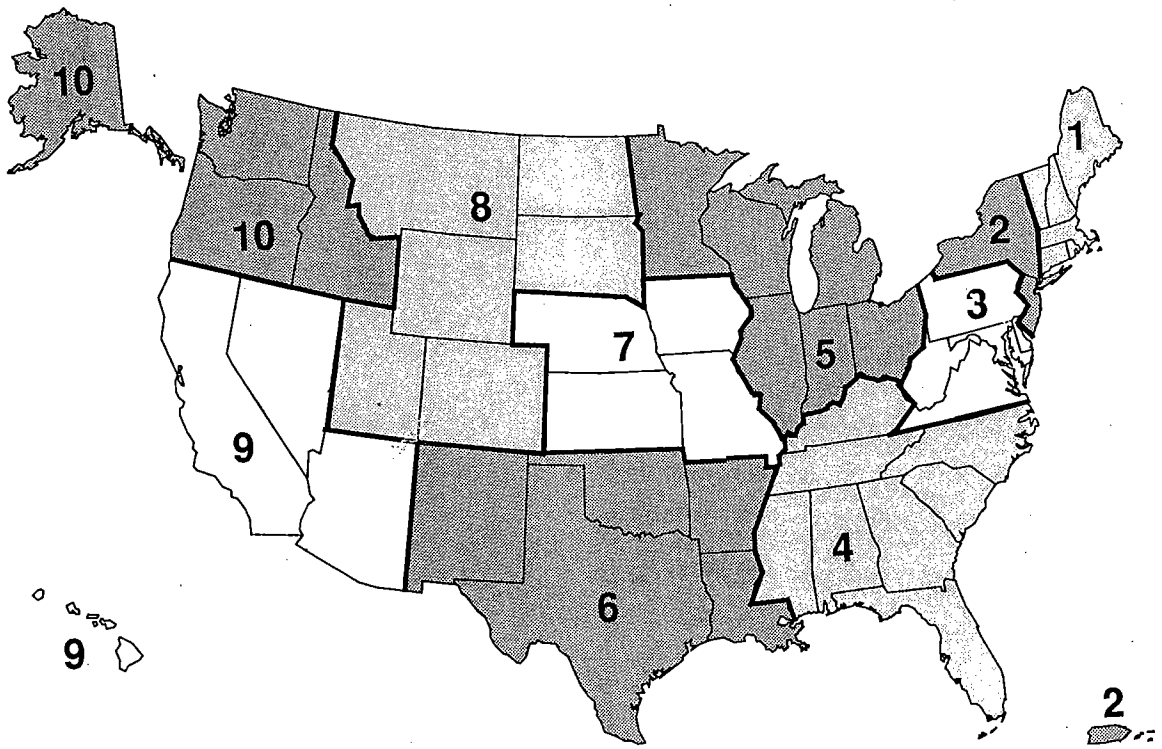

Figure 2-3. Ten Regions of the U.S. Environmental Protection Agency.

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3. NATIONAL AND REGIONAL TRENDS IN NAAQS POLLUTANTS

EPA has set National Ambient Air Quality Standards (NAAQS) for six pollutants considered harmful to public health: particulate matter [formerly as total suspended particulates (TSP), now as particulates less than 10 microns in diameter (PM-10)], sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3) and lead (Pb). This chapter focuses on both 10-year (1981-90) trends and recent changes in air quality and emissions for these six pollutants. Changes since 1988, and comparisons between all the trend sites and the subset of National Air Monitoring Stations (NAMS) are highlighted. Trends are examined for both the nation and the ten EPA Regions.

As in previous reports, the air quality trends are presented using trend lines, confidence intervals, boxplots and bar graphs. The reader is referred to Section 2.2 for a detailed description of the confidence interval and boxplot procedures. The plotting conventions for the confidence intervals and boxplots are shown in Figures 2-1 and 2-2, respectively. Boxplots of all trend sites are presented for each year in the 10-year trend. Recent changes are presented using the 3-year data base, 1988 through 1990. The recent 3-year period is presented to take advantage of the larger number of sites for all but particulates, and of sites that have operated continuously during the last three years.

Trends are also presented for annual nationwide emissions of particulate matter, sulfur oxides (SO_x), carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOC) and lead (Pb). These emissions data are estimated using best available engineering calculations. The reader is referred to a companion report for a detailed description of emission trends, source categories and estimation procedures.[1] For particulates, emission estimates are presented both in terms of total particulate (TP), which includes all particles regardless of size, and for PM-10. This report presents short-term particulate matter trends relating to PM-10 air quality and emissions data.

While the ambient data trends and the emission trends can be viewed as independent assessments that lend added credence to the results, the emission estimates can also be used to provide information on trends over longer time periods. Because of changes that have occurred in ambient monitoring measurement methodology and the change over time in the geographical distribution of monitors, it is difficult to provide ambient trends going back to 1970, other than for TSP, and yet it is important not to lose sight of some of the earlier progress that was made in air pollution control. Emission estimates can provide some insight in this area. Figure 3-1 depicts long-term change in emission estimates. Lead clearly shows the most impressive decrease of 97 percent but improvements are also seen for TP (-59 percent), SO_x (-25 percent), CO (-41 percent) and VOC (-31 percent). Only NO_x has not shown improvement with emissions estimated to have increased 6 percent from 1970 levels, due primarily to increased fuel combustion by stationary sources. However, the 1990 NO_x emissions estimate is 6 percent lower than the estimate for 1981. Los Angeles is the only metropolitan area that currently does not meet the NO_2 NAAQS.

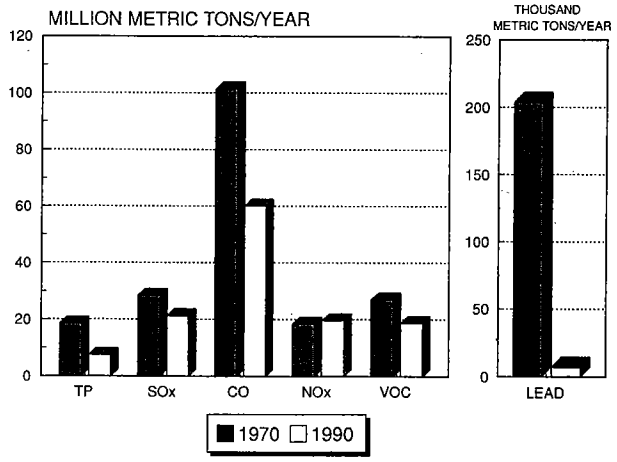

Figure 3-1. Comparison of 1970 and 1990 emissions.

3.1 TRENDS IN PARTICULATE MATTER

Air pollutants called particulate matter include dust, dirt, soot, smoke and liquid droplets directly emitted into the air by sources such as factories, power plants, cars, construction activity, fires and natural windblown dust as well as particles formed in the atmosphere by condensation or transformation of emitted gases such as sulfur dioxide and volatile organic compounds.

Annual and 24-hour National Ambient Air Quality Standards (NAAQS) for particulate matter were first set in 1971. Total suspended particulate (TSP) was the indicator used to represent suspended particles in the ambient air. TSP is measured using a high volume sampler (Hi-Vol) which collects suspended particles ranging up to approximately 45 micrometers in diameter.

On July 1, 1987 EPA promulgated new annual and 24-hour standards for particulate matter, using a new indicator, PM-10, that includes only those particles with aerodynamic diameter smaller than 10 micrometers. These smaller particles are likely responsible for most adverse health effects of particulate because of their ability to reach the thoracic or lower regions of the respiratory tract. The original (TSP) standards were an annual geometric mean of 75 $\mu g/m^3$, not to be exceeded, and a 24-hour concentration of 260 $\mu g/m^3$, not to be exceeded more than once per year. The new (PM-10) standards specify an expected annual arithmetic mean not to exceed 50 $\mu g/m^3$ and an expected number of 24-hour concentrations greater than 150 $\mu g/m^3$ per year not to exceed one.

With the change from TSP to PM-10 as the indicator for particulate matter, the number of TSP monitors has been steadily declining and a network of locations to monitor PM-10 has evolved. Figure 3-2 shows the 10-year decline of the number of TSP monitors nationally, contrasted with the developing PM-10 network. Approximately 1300 PM-10 sites were active in 1990, compared with less that 1100 for TSP. In 1981 there were approximately 4000 TSP monitoring locations.

There are basically two types of reference instruments currently used to sample PM-10. The first is essentially a Hi-Vol, like the one used for TSP, but with a different size selective inlet (SSI). This sampler uses an inert quartz filter. The other type of instrument is a "dichotomous" sampler. It uses a different PM-10 inlet, operates at a slower flow rate, and produces two separate samples: 2.5 to 10 microns and less than 2.5 microns, each collected on a teflon filter.

With the new PM-10 standards, more emphasis is being placed on detection of peak 24-hour concentrations. Unlike monitoring regulations for TSP which only required once in 6-day sampling, new specifications for PM-10 now dictate more frequent sampling. Approximately 15 percent of all PM-10 sampling sites operate either every other day or everyday. In contrast, only 5 percent of TSP Hi-Vols had been operating more frequently than once in 6 days.

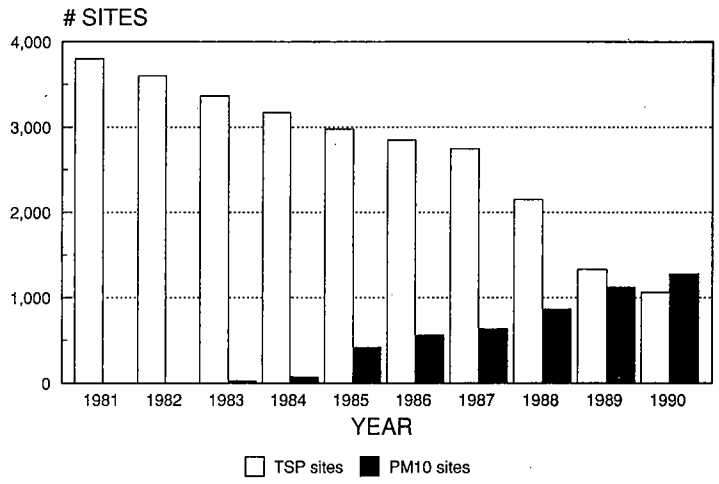

Figure 3-2. National trend in the number of TSP and PM-10 monitoring locations, 1981-1990.

Although some monitoring for PM-10 was initiated prior to promulgation of the new standards, most networks did not produce data with approved reference samplers until mid-1987 or 1988. Thus, only a limited data base is currently available to examine trends in PM-10 air quality and longer-term trends in particulate matter can only be based on TSP. Both 10-year trends and recent 3-year changes in TSP are presented in terms of average air quality (annual geometric mean). Available information on PM-10 air quality will be used to report the 1988-1990 changes in PM-10 concentration levels. Two PM-10 statistics are presented. The annual arithmetic mean concentration is used to reflect average air quality, and the 90th percentile of 24-hour concentrations is used to represent the behavior of peak concentrations. Because PM-10 sampling frequency varies among sites and may have changed during the 3-year period, the 90th percentile is used. This statistic is less sensitive to changes in sampling frequency than the peak values. Finally, cross sectional PM-10 data are included for the more comprehensive data available for calendar year 1990.

3.1.1 Long-term TSP Trends: 1981-90

The 10-year trend in national average TSP levels, 1981 through 1990, is shown in Figure 3-3 for 1265 sites geographically distributed throughout the Nation. In addition, the entire distribution of geometric mean concentrations among all locations are depicted with box-plots.

Measured TSP concentrations appear to have declined about 15 percent between 1981 and 1982 and are relatively stable during the last 9 years. However, the data collected in 1981 (as well as 1979 and 1980) may have been affected by the type of filters used to collect the TSP.[2-5] For this reason, the portion of Figure 3-3 showing the data for 1981 is shaded to indicate the uncertainty in these TSP measurements. Despite this uncertainty, some of the observed decrease in ambient particulate matter between 1981 and 1982 is thought to be real (a 20 percent decrease between 1978 and 1982 has been well documented).[6] However, since the exact magnitude of the 1981-1982 change is uncertain, the longer-term change in total particulate concentrations is best described in terms of the 9-year period 1982-1990.

Nationally, the composite average TSP levels declined 3 percent from 1982 to 1990. Upon close inspection, some changes in composite means since 1982 are evident. Although the levels over the last 9 years are relatively stable, the national TSP levels in 1990 are statistically lower than those produced in 1987, 1988 and all years prior to 1985. In fact, they are the lowest national numbers reported in EPA's trends reports. The recent changes in total suspended particulate matter will be discussed in more detail in Section 3.1.3.

3.1.2 Total Particulate Emission Trends

Nationwide Total Particulate (TP) emission trends from historical inventoried sources show an overall decrease of 6 percent from 1981 to 1990. (See Table 3-1 and Figure 3-4). The general 10-year emission pattern has similarity to that of composite average air quality. Both showed a

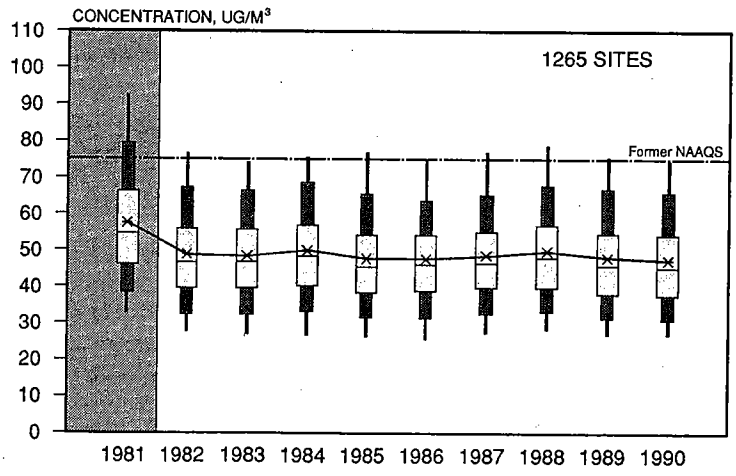

Figure 3-3. Boxplot comparisons of trends in annual geometric mean total suspended particulate concentrations at 1265 sites, 1981-1990.

relatively large decline between 1981 and 1982. This similarity appears to reduce some of the uncertainty in the large reported decrease in ambient concentrations between 1981 and 1982. The emissions also increased in 1988 and again in 1990, both times due to atypically large forest fires. In 1990, the fires occurred in Alaska, but since there are relatively few TSP monitors in Alaska, the ambient trends did not follow. The 4 percent increase in TP emissions between 1989 and 1990 are partly responsible for the relatively lower 10-year emission trends than those presented in last year's report. In fact, the emissions from 1982 to 1990 increased 6 percent. In any case, the trend in TP emissions is normally not expected to agree precisely with the trend in ambient TSP levels due to unaccounted for natural particulate matter background and uninventoried emission sources such as unpaved roads and construction activity. Such fugitive emissions are not considered in estimates of the annual nationwide total and could be significant in populated areas. Information on these sources is presented in terms of the PM-10 portion of particulate matter in Section 3.1.5. Total particulate emission estimates also exclude significant contributions from gas phase particulate matter precursors (principally sulfur oxides and nitrogen oxides). The 10-year reductions in inventoried total particulate emissions occurred primarily in the fuel

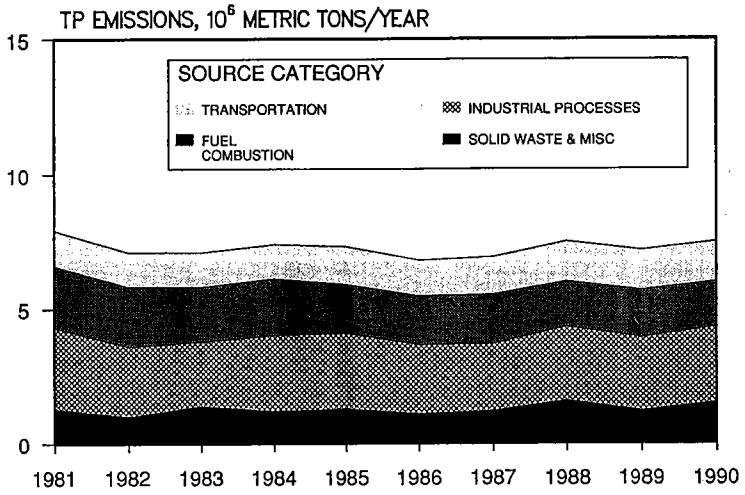

Figure 3-4. National trend in total particulate emissions, 1981-1990.

TABLE 3-1. National Total Particulate Emission Estimates, 1981-1990

(million metric tons/year)

SOURCE CATEGORY	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Transportation	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.5
Fuel Combustion	2.3	2.2	2.0	2.1	1.8	1.8	1.8	1.7	1.8	1.7
Industrial Processes	3.0	2.6	2.4	2.8	2.8	2.6	2.5	2.7	2.7	2.8
Solid Waste	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Miscellaneous	0.9	0.7	1.1	0.9	1.0	0.8	0.9	1.3	0.9	1.2
TOTAL	8.0	7.1	7.1	7.4	7.2	6.7	6.9	7.5	7.2	7.5

NOTE: The sums of sub-categories may not equal total due to rounding.

3 percent of all monitoring stations reported averages above the annual standard in this year.

Although the 90th percentile is a reasonable peak concentration indicator for temporal comparisons, it does not directly relate to the 150 $\mu g/m^3$ level of the 24-hour PM-10 standard. Since this standard permits one expected exceedance per year, the maximum and second maximum 24-hour concentrations provide a more direct indication of attainment status. A comparison of the 90th percentile of 24-hour concentrations to these other indicators of peak concentrations is presented in Figure 3-7 using boxplots of the 1990 national concentration distribution. Although the 90th percentile concentrations are well below 150 $\mu g/m^3$, maximum concentrations exceed the standard at 9 percent of the reporting locations while the second maximum concentrations exceed at 4 percent.

Figure 3-8 presents the Regional distribution of PM-10 concentrations for both average and 90th percentile concentrations among the 979 stations producing reference measurements in 1990. On the average, the highest annual mean and peak 24-hour concentrations are found in Region IX.

The 90th percentile of 24-hour concentrations has been used as the indicator of peak concentrations because of differences in sampling frequency among PM-10 sampling locations. Note that average sampling frequency varies among Regions, with samplers in Regions VIII and X operating at approximately twice the frequency of samplers in, say, Region II and Region IX. The monitoring regulations permit such differences in sampling frequency. The regulations specify that areas that are close to the 24-hour standard must sample more frequently.

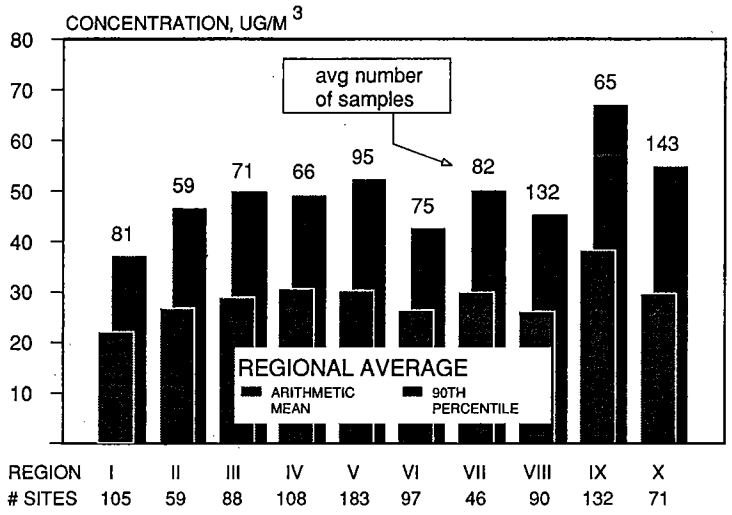

Figure 3-8. Regional comparisons of annual mean and 90th percentile of 24-hour PM-10 concentrations for 1990.

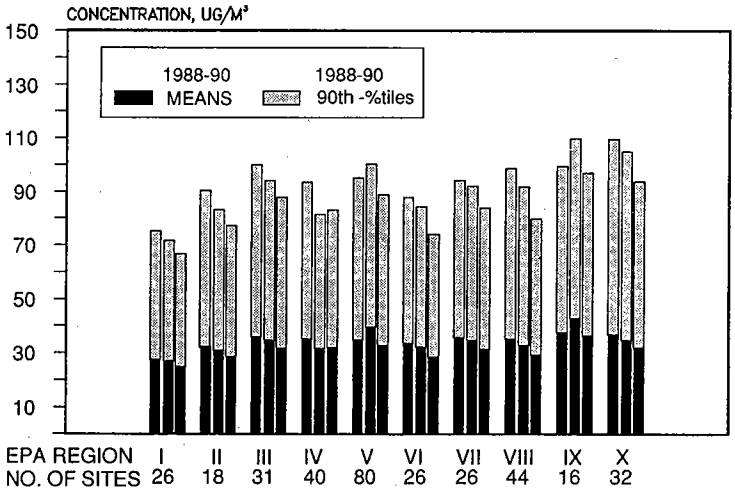

Figure 3-9. Regional changes in annual average and 90th percentile of 24-hour PM-10 concentrations, 1988-1990.

Figure 3-9 presents the 1988 to 1990 changes in annual average and 90th percentile PM-10 concentrations by EPA Region. The 3-year national decrease is evident in all Regions. Most of this decrease occurred everywhere between 1989 and 1990. On the other hand, average PM-10 concentrations in Region IV displayed a minor increase between 1989 and 1990. Recalling that Region IV was the only Region with an increase in total particulates, this outcome may be related to drier conditions throughout the southeast in 1990.

3.1.5 PM-10 Emission Trends

Trends in the PM-10 portion of historically inventoried particulate matter emissions are presented for the 6-year period, 1985-1990 in Table 3-2. Comparing Tables 3-1 and 3-2, PM-10 appears to represent essentially all of the particulate emissions from transportation and industrial sources and most of the emissions in the other source categories. As was the case for TP, higher emissions occurred in 1988 and 1990 due to forest fires. Total PM-10 emissions increased 5 percent since 1989, 2 percent since 1988 and 7 percent since 1985.

National estimates are also provided for PM-10 fugitive emissions for 1985-1990, in Table 3-3. These estimates provide a good indication of the relative impacts of major contributors to particulate matter air quality. In total, these fugitive emissions are 6 to 8 times more than the historically inventoried particulate matter sources categories.

Note that PM-10 estimates are not included for contributions from gas phase particulate matter precursors, principally sulfur oxides and nitrogen oxides.

Construction activity and unpaved roads are consistently the major contributors over time for most Regions. Nationally, roadway particulate matter emissions are estimated to have increased due to increased vehicle traffic. Among road types, emissions from unpaved and paved roads are estimated to have increased 6 percent and 22 percent, respectively, since 1985. Emissions from unpaved roads are highest in Regions which cover large geographic areas. Emissions due to construction are estimated to have decreased over 21 percent since 1985 due to reduced activity in this industry.

TABLE 3-2. National PM-10 Emission Estimates, 1985-1990

	(million metric tons/year)					
SOURCE CATEGORY	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Transportation	1.3	1.3	1.3	1.4	1.5	1.5
Fuel Combustion	1.1	1.1	1.1	1.1	1.1	1.1
Industrial Processes	2.7	2.5	2.4	2.6	2.6	2.7
Solid Waste	0.3	0.2	0.2	0.2	0.2	0.2
Miscellaneous	0.7	0.5	0.7	1.0	0.7	0.9
TOTAL	6.0	5.6	5.8	6.3	6.1	6.4

NOTE: The sums of sub-categories may not equal total due to rounding.

Agricultural activity is a smaller contributor to the national total, but estimated to the major source in specific Regions. Tilling is estimated to be a big contributor in Regions V, VII, VIII and X, but has not shown much change over the 6-year period. Wind erosion particulate emissions are estimated to be extremely variable from year to year and can also be a major contributor in some Regions. Particulate emissions due to wind erosion are very sensitive to Regional soil conditions and year-to-year changes in total precipitation. Accordingly, estimated emissions from wind erosion were extremely high for the drought year of 1988, particularly for Regions VI and VII. Finally, among all fugitive categories surveyed, mining and quarrying is estimated to be a relatively small contributor to total fugitive particulate matter emissions.[1]

3.1.6 Visibility Trends

Many parts of the nation have experienced long-term impairment in visibility due to build-up of emissions around urban areas and from long range transport of small particles (< 2.5 microns) across broad regions of the country. This increase in haze has occurred in the summer season across the Eastern U.S., although there has been improvement in the winter. In the Eastern and Southwestern U.S., regional visibility is mostly attributed to sulfates formed by release of sulfur oxides. In the Northwestern U.S., carbon particles play an important role in the degradation. The Clean Air Act Amendments of 1990 will address regional haze in the East through the acid rain program which will substantially reduce sulfur oxides emissions. To address regional haze in the West, the new Act has strengthened the work already started on protection of visibility in national park and wilderness areas. Required research will focus on transport mechanisms and atmospheric conditions which contribute to hazes.

TABLE 3-3. National PM-10 Fugitive Emission Estimates, 1985-1990

(million metric tons/year)

SOURCE CATEGORY	1985	1986	1987	1988	1989	1990
Agricultural Tilling	6.2	6.3	6.4	6.4	6.3	6.3
Construction	11.5	10.7	11.0	10.6	10.2	9.1
Mining and Quarrying	0.3	0.3	0.3	0.3	0.3	0.3
Paved Roads	5.9	6.1	6.5	6.9	7.0	7.2
Unpaved Roads	13.3	13.3	12.7	14.2	13.9	14.1
Wind Erosion	3.2	8.5	1.3	15.9	10.7	3.8
TOTAL	40.5	45.3	38.1	54.3	48.5	40.8

NOTE: The sums of sub-categories may not equal total due to rounding.

3.2 TRENDS IN SULFUR DIOXIDE

Ambient sulfur dioxide (SO_2) results largely from stationary source coal and oil combustion, refineries, pulp and paper mills and from nonferrous smelters. There are three NAAQS for SO_2: an annual arithmetic mean of 0.03 ppm (80 $\mu g/m^3$), a 24-hour level of 0.14 ppm (365 $\mu g/m^3$) and a 3-hour level of 0.50 ppm (1300 $\mu g/m^3$). The first two standards are primary (health-related) standards, while the 3-hour NAAQS is a secondary (welfare-related) standard. The annual mean standard is not to be exceeded, while the short-term standards are not to be exceeded more than once per year. The trend analyses which follow are for the primary standards. It should be noted that EPA is currently evaluating the need for a new shorter-term 1-hour standard.[8]

High concentrations of SO_2 affect breathing and may aggravate existing respiratory and cardiovascular disease. Sensitive populations include asthmatics, individuals with bronchitis or emphysema, children and the elderly. Although this report does not directly address trends in acid deposition, of which SO_2 is a major contributor, it does include information on total nationwide emissions which is a measure relating to total atmospheric loadings. SO_2 also produces foliar damage on trees and agricultural crops.

The trends in ambient concentrations are derived from continuous monitoring instruments which can measure as many as 8760 hourly values per year. The SO_2 measurements reported in this section are summarized into a variety of summary statistics which relate to the SO_2 NAAQS. The statistics on which ambient trends will be reported are the annual arithmetic mean concentration, the second highest annual 24-hour average (summarized midnight to midnight), and the expected annual number of 24-hour exceedances of the 24-hour standard of 0.14 ppm.

3.2.1 Long-term SO_2 Trends: 1981-90

The long-term trend in ambient SO_2, 1981 through 1990, is graphically presented in Figures 3-10 through 3-12. In each figure, the trend at the NAMS is contrasted with the trend at all sites. For each of the statistics presented, a 10-year downward trend is evident, although the rate of decline has slowed over the last 3 years. Nationally, the annual mean SO_2, examined at 457

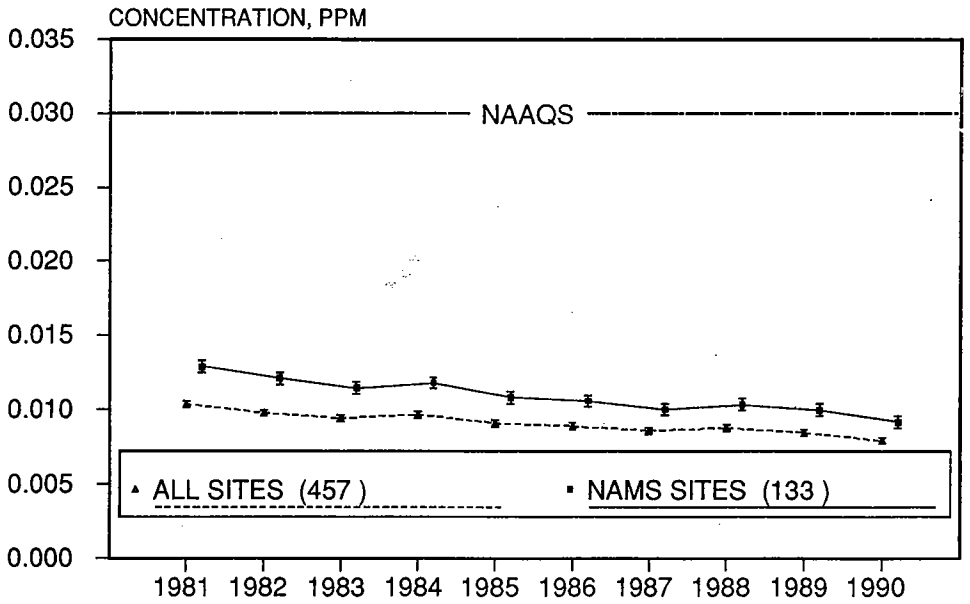

Figure 3-10. National trend in annual average sulfur dioxide concentration at both NAMS and all sites with 95 percent confidence intervals, 1981-1990.

sites, decreased at a median rate of approximately 2 percent per year; this resulted in an overall change of about 24 percent (Figure 3-10). The subset of 133 NAMS recorded higher average concentrations but declined at a median rate of 3 percent per year, with a net change of 29 percent for the 10-year period.

The annual second highest 24-hour values displayed a similar improvement between 1981 and 1990. Nationally, among 452 stations with adequate trend data, the median rate of change was 3 percent per year, with an overall decline of 30 percent (Figure 3-11). The 134 NAMS exhibited an overall decrease of 33 percent. The estimated number of exceedances also showed declines for the NAMS as well as for the composite of all sites (Figure 3-12). The national composite estimated number of exceedances decreased 87 percent from 1981 to 1990. However, the vast majority of SO_2 sites do not show any exceedances of the 24-hour NAAQS. Most of the exceedances, as well as the bulk of the improvements, occurred at source-oriented sites.

The statistical significance of these long-term trends is graphically illustrated in Figures 3-10 to 3-12 with the 95 percent confidence intervals. These figures show that the 1990 composite average and composite second maximum 24-hour SO_2 levels are the lowest reported in EPA trends reports. The 1990 composite annual mean is statistically lower than all previous years. Similarly, the composite 1990 peak values are statistically different than all years except for 1987.

The inter-site variability for annual mean and annual second highest 24-hour SO_2 concentrations is graphically displayed in Figures 3-13 and 3-14. These figures show that

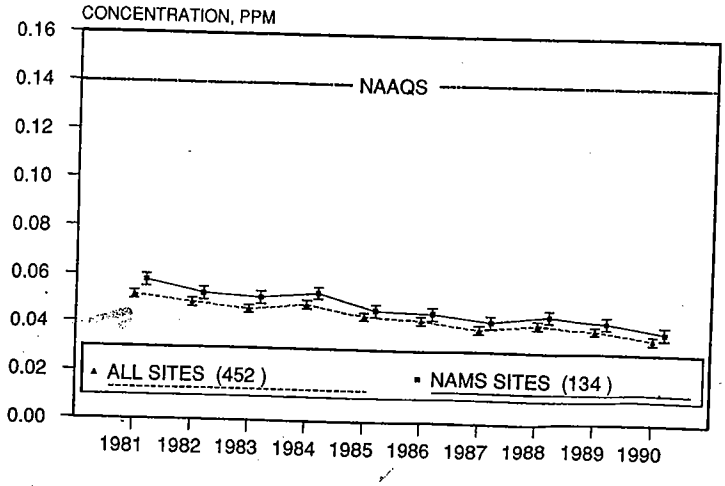

Figure 3-11. National trend in the second-highest 24-hour sulfur dioxide concentration at both NAMS and all sites with 95 percent confidence intervals, 1981-1990.

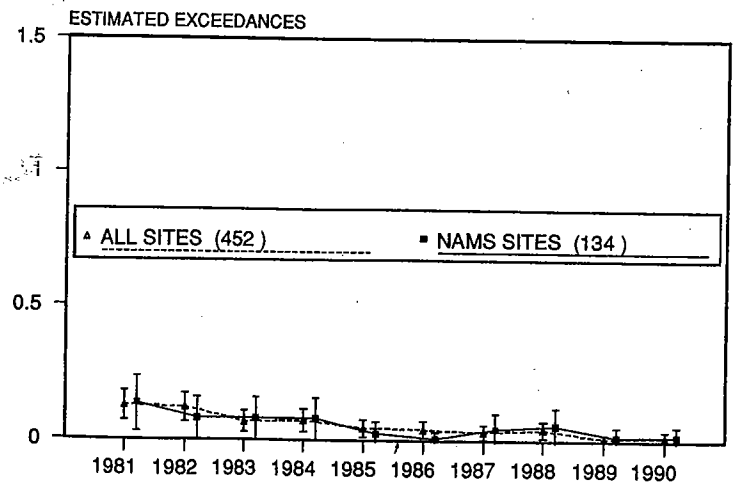

Figure 3-12. National trend in the estimated number of exceedances of the 24-hour sulfur dioxide NAAQS at both NAMS and all sites with 95 percent confidence intervals, 1981-1990.

higher concentration sites decreased more rapidly and that the concentration range among sites has also diminished during the 1980's.

Nationally, sulfur oxides (SO_x) emissions decreased 6 percent from 1981 to 1990 (Figure 3-15 and Table 3-4). This decrease is attributable to three general changes.[1] First, the decrease is attributable to the installation of flue gas desulfurization controls at new coal-fired electric generating stations and a reduction in the average sulfur content of fuels consumed over the 10-year period. Second, emissions from industrial processes have declined, primarily as the result of controls implemented to reduce emissions from nonferrous smelters and sulfuric acid manufacturing plants, as well as shutdowns of some large smelters. Finally, emissions from other stationary source fuel combustion sectors also declined, mainly due to decreased combustion of coal by these consumers. The 2 percent increase in sulfur oxides emissions between 1989 and 1990 is attributed to a projected increase in electric generation.

The disparity between 10-year trends and 2-year changes in SO_2 air quality and SO_x emissions can be attributed to several factors. SO_2 monitors with sufficient historical data for trends are mostly urban population-oriented. They do not monitor many of the major emitters which tend to be located in more rural areas (e.g. large power plants).

Although most of the trend sites are categorized as population-oriented, the majority of SO_x emissions are dominated by large point sources. Seventy percent of all national SO_x emissions are generated by electric utilities (92 percent of which come from coal fired power plants). The majority of

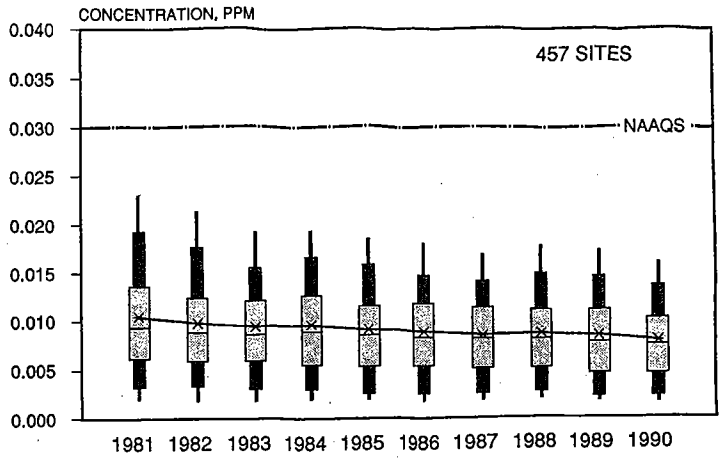

Figure 3-13. Boxplot comparisons of trends in annual mean sulfur dioxide concentrations at 457 sites, 1981-1990.

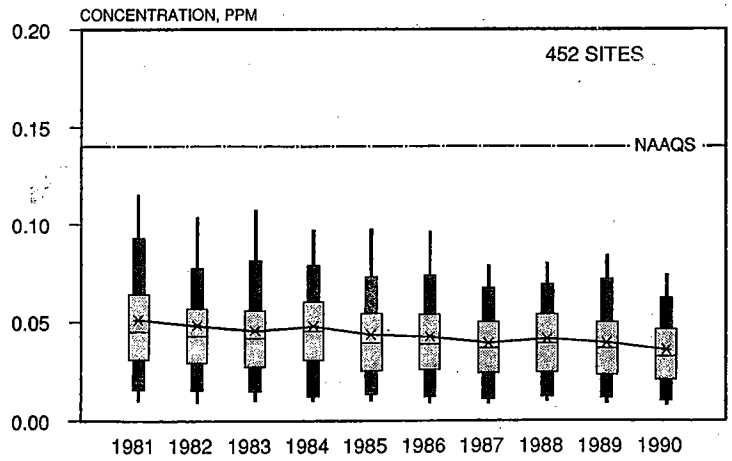

Figure 3-14. Boxplot comparisons of trends in second highest 24-hour average sulfur dioxide concentrations at 452 sites, 1981-1990.

these emissions, however, are produced by a small number of facilities. Fifty individual plants in 15 states account for approximately one-half of all power plant emissions. In addition, the 200 highest SO_x emitters account for more than 86 percent of all SO_x power plant emissions. These 200 plants shown in Figure 3-16 account for 60 percent of all SO_x emissions nationally.[9]

Title IV of the Clean Air Act Amendments of 1990 addresses the control of pollutants associated with acid deposition and includes a goal of reducing sulfur oxide emissions by 10 million tons relative to 1980 levels. The focus in this control program is an innovative market-based emission allowance program which will provide affected sources flexibility in meeting the mandated emission reductions. This is the first large scale regulatory use of market-based incentives.

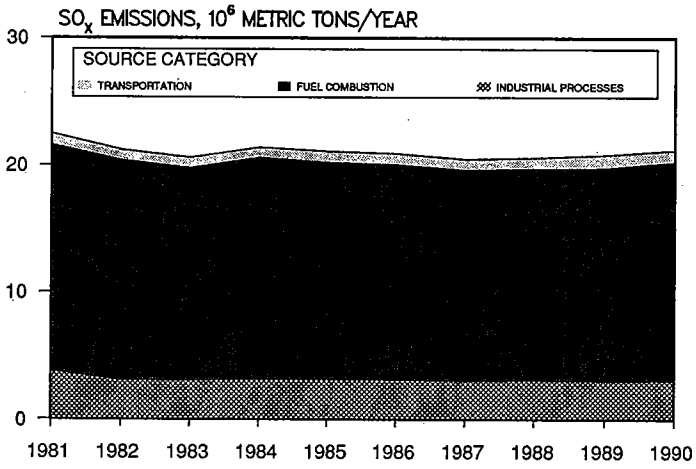

Figure 3-15. National trend in sulfur oxides emissions, 1981-1990.

TABLE 3-4. National Sulfur Oxides Emission Estimates, 1981-1990

	(million metric tons/year)									
SOURCE CATEGORY	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Transportation	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.9
Fuel Combustion	17.8	17.3	16.7	17.4	17.0	16.9	16.6	16.6	16.8	17.1
Industrial Processes	3.8	3.1	3.1	3.2	3.2	3.2	3.0	3.1	3.0	3.1
Solid Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	22.5	21.2	20.6	21.5	21.1	20.9	20.5	20.6	20.8	21.2

NOTE: The sums of sub-categories may not equal total due to rounding.

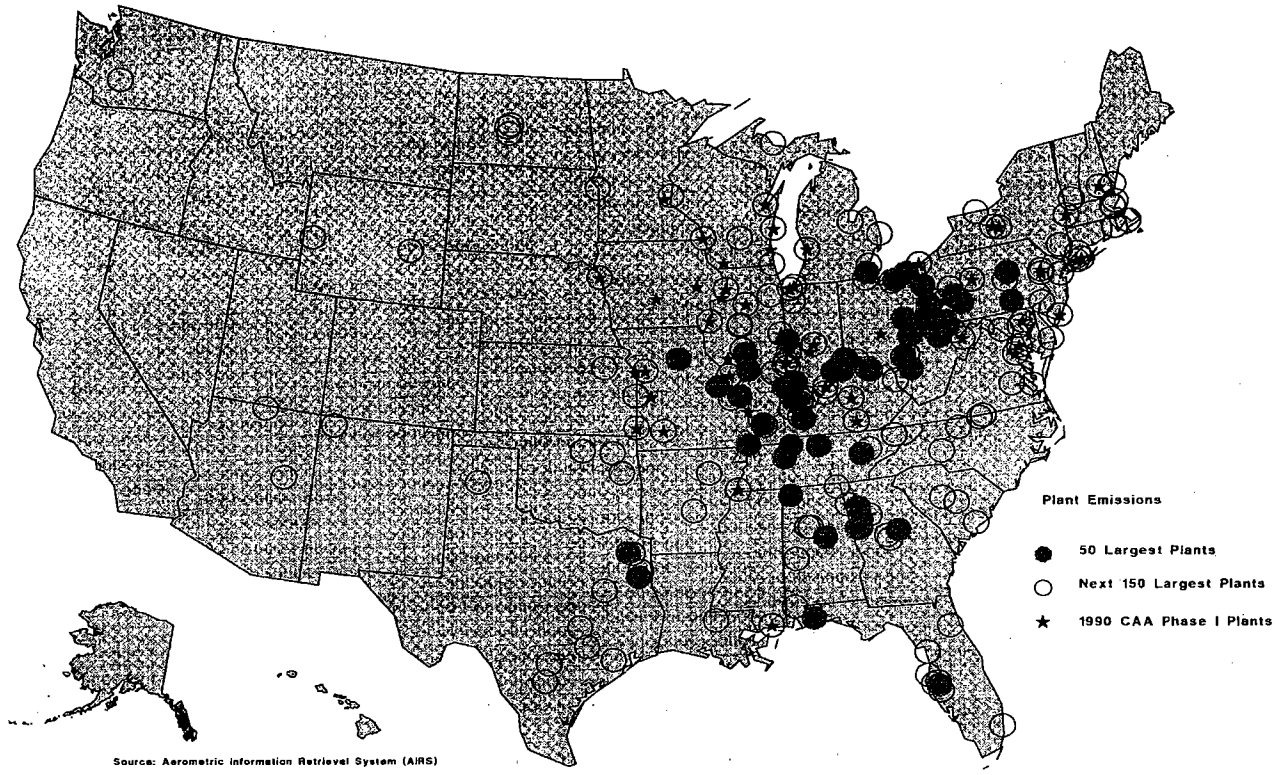

Figure 3-16. Location of the 200 largest power plant emitters of sulfur oxides.

Figure 3-16 shows 110 power plants which are required by the 1990 Clean Air Act Amendments to reduce emissions to specified allowable tonnage by January 1, 1995. This will accomplish Phase I of the legislated ten million ton reductions.

Another factor which may account for differences in SO_x emissions and ambient air quality is stack height. At large utilities and smelters, SO_x is generally released into the atmosphere through tall stacks. Although sources are not permitted to increase emissions through increased dispersion from tall stacks, measured ground level concentrations in the vicinity of these existing sources may not reflect local emissions. Total atmospheric loading impacts also arise, in part, as a consequence of tall stacks.

3.2.2 Recent SO_2 Trends: 1988-90

Nationally, SO_2 showed improvement over the last three years in both average and peak 24-hour concentrations. Composite annual mean concentrations consistently decreased for a total of 11 percent between 1988 and 1990. Over the last 2 years, the average annual mean SO_2 decrease was 7 percent. Composite 24-hour SO_2 concentrations declined 15 percent since 1988 and 11 percent since 1989.

Figure 3-17 presents the Regional changes in composite annual average SO_2 concentrations for the last 3 years, 1988-1990. All Regions except for the Northwest (Region X) follow the national pattern of change in annual mean SO_2. Although not presented here in graphical format, every Region of the country reported 3-year declines in peak 24-hour SO_2 concentrations.

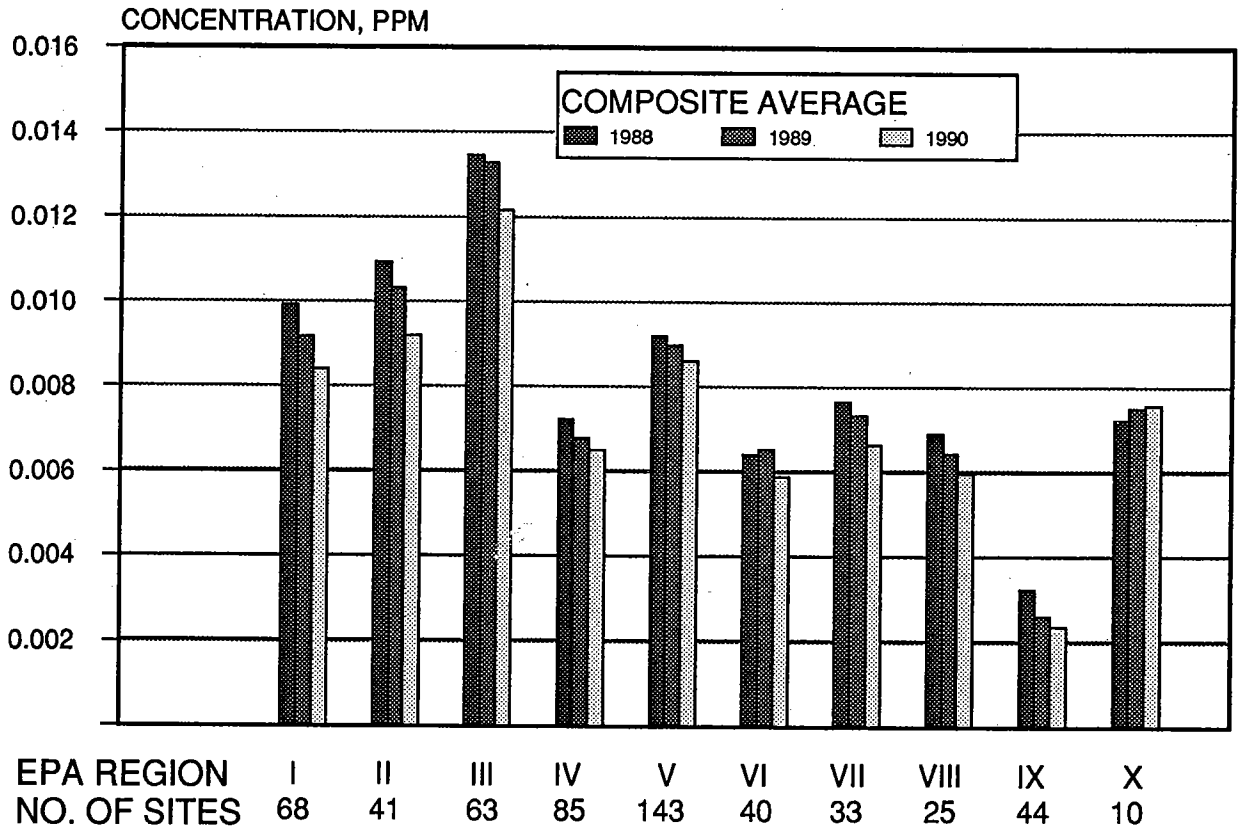

Figure 3-17. Regional comparisons of the 1988, 1989, 1990 composite averages of the annual average sulfur dioxide concentrations.

3.3 TRENDS IN CARBON MONOXIDE

Carbon monoxide (CO) is a colorless, odorless and poisonous gas produced by incomplete burning of carbon in fuels. Two-thirds of the nationwide CO emissions are from transportation sources, with the largest contribution coming from highway motor vehicles. The NAAQS for ambient CO specify upper limits for both 1-hour and 8-hour averages that are not to be exceeded more than once per year. The 1-hour level is 35 ppm, and the 8-hour level is 9 ppm. This trends analysis focuses on the 8-hour average results because the 8-hour standard is generally the more restrictive limit. Nationally, during 1990, only two exceedances of the CO 1-hour NAAQS were recorded at a site which is impacted by a localized, non-mobile source, and in each case the 8-hour NAAQS was still the controlling standard.

Carbon monoxide enters the bloodstream and reduces the delivery of oxygen to the body's organs and tissues. The health threat is most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease. Exposure to elevated carbon monoxide levels is associated with impairment of visual perception, manual dexterity, learning ability and performance of complex tasks.

Trends sites were selected using the procedures presented in Section 2.1 which yielded a data base of 301 sites for the 10-year period 1981-90 and a data base of 359 sites for the 3-year 1988-90 period. There were 92 NAMS sites included in the 10-year data base and 104 NAMS sites in the 3-year data base.

3.3.1 Long-term CO Trends: 1981-90

The 1981-90 composite national average trend is shown in Figure 3-18 for the second highest non-overlapping 8-hour CO concentration for the 301 long-term trend sites and the subset of 92 NAMS sites. During this 10-year period, the national composite average decreased by 29 percent and the subset of NAMS decreased by 32 percent. Both curves show similar trends for the NAMS and the larger group of long-term trend sites. The median rate of improvement for this time period is more than 3 percent per year. Except for a small upturn between 1985 and 1986, composite average levels have shown a steady decline throughout this period. Long-term improvement was seen in each EPA Region with median rates of improvement varying from 2 to 5 percent per year. The 1990 composite average is significantly lower than the composite means for 1986 and earlier years. This same trend is shown in Figure 3-19 by a boxplot presentation which provides more information on the year-to-year distribution of ambient CO levels at the long-term trend sites. While there is some year to year fluctuation in certain percentiles, the general long-term improvement in ambient CO levels is clear.

Figure 3-20 displays the 10-year trend in the composite average of the estimated number of exceedances of the 8-hour CO NAAQS. This exceedance rate was adjusted to account for incomplete sampling. The trend in exceedances shows long-term improvement but the rates are much higher than those for the second maximums. The composite average of estimated exceedances decreased 87 percent between 1981 and 1990 for the 301 long-term trend sites, while the subset of 92 NAMS showed an 86 percent decrease. These percentage changes for exceedances are typically much larger than those found for peak concentrations. The trend in annual second maximum 8-hour value is more likely to reflect the change in emission levels. For both curves, the 1990 composite average of the estimated exceedances is significantly lower than levels for 1986 and earlier years.

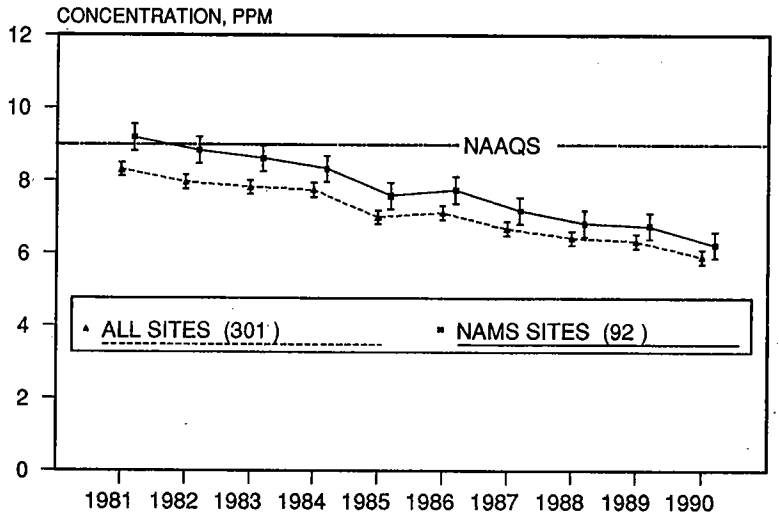

Figure 3-18. National trend in the composite average of the second highest nonoverlapping 8-hour average carbon monoxide concentration at both NAMS and all sites with 95 percent confidence intervals, 1981-1990.

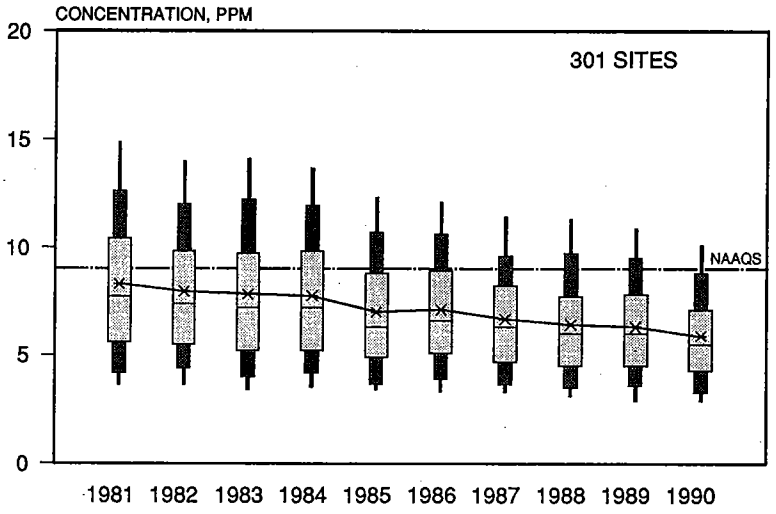

Figure 3-19. Boxplot comparisons of trends in second highest nonoverlapping 8-hour average carbon monoxide concentrations at 301 sites, 1981-1990.

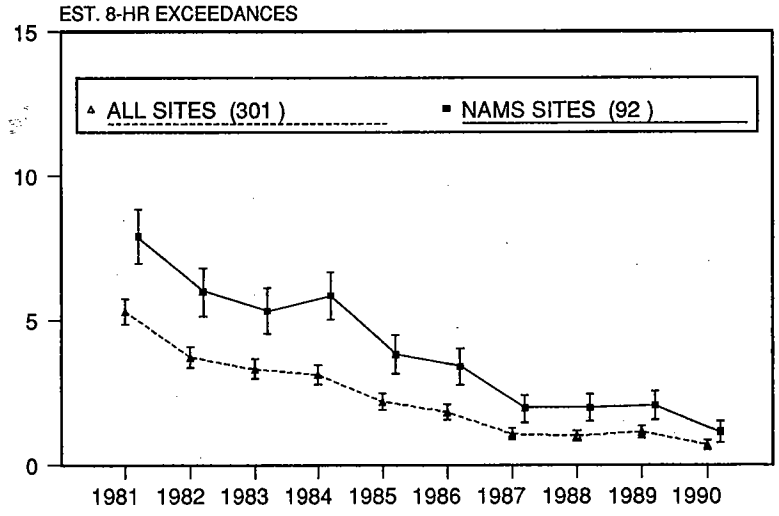

Figure 3-20. National trend in the composite average of the estimated number of exceedances of the 8-hour carbon monoxide NAAQS, at both NAMS and all sites with 95 percent confidence intervals, 1981-1990.

The 10-year 1981-90 trend in national carbon monoxide emission estimates is shown in Figure 3-21 and in Table 3-5. The estimates for emissions from forest fires for the years 1985 through 1989 have been revised downward about 9 percent, from the levels reported in last year's report.[6] However, this decrease in forest fire emissions yields only a 1 percent change in total emissions for 1985-1989. These estimates show a 22 percent decrease in total emissions between 1981 and 1990. Transportation sources accounted for approximately 71 percent of the total in 1981 and decreased to 63 percent of total emissions in 1990. Emissions from highway vehicles decreased 37 percent during the 1981-90 period, despite a 37 percent increase in vehicle miles of travel.[1] Figure 3-22 contrasts the 10-year increasing trend in vehicle miles traveled (VMT) with the declining trend in carbon monoxide emissions from highway vehicles. This indicates that the Federal Motor Vehicle Control

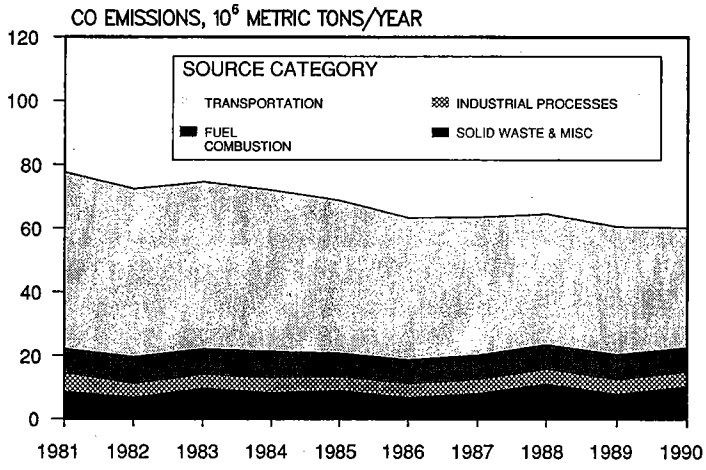

Figure 3-21. National trend in carbon monoxide emissions, 1981-1990.

TABLE 3-5. National Carbon Monoxide Emission Estimates, 1981-1990

	(million metric tons/year)									
SOURCE CATEGORY	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Transportation	55.4	52.9	52.4	50.6	47.9	44.6	43.3	41.2	40.0	37.6
Fuel Combustion	7.7	8.2	8.2	8.3	7.5	7.5	7.6	7.6	7.8	7.5
Industrial Processes	5.9	4.4	4.3	4.7	4.4	4.2	4.3	4.6	4.6	4.7
Solid Waste	2.1	2.0	1.9	1.9	1.9	1.8	1.8	1.7	1.7	1.7
Miscellaneous	6.4	4.9	7.8	6.4	7.1	5.1	6.4	9.5	6.3	8.6
TOTAL	77.5	72.5	74.5	71.9	68.7	63.2	63.4	64.7	60.4	60.1

NOTE: The sums of sub-categories may not equal total due to rounding.

Program (FMVCP) has been effective on the national scale, with controls more than offsetting growth during this period. While there is general agreement between changes in air quality and emissions over this 10-year period, it is worth noting that the emission changes reflect estimated national totals, while ambient CO monitors are frequently located to identify local problems. The mix of vehicles and the change in vehicle miles of travel in the area around a specific CO monitoring site may differ from the national averages.

3.3.2 Recent CO Trends: 1988-1990

This section examines ambient CO changes during the last 3 years, 1988-90 at sites that recorded data in all three years. Between 1989 and 1990, the composite average of the second highest non-overlapping 8-hour average concentration at 359 sites decreased by 8 percent and by 9 percent at the 104 NAMS sites. The composite average of the estimated number of exceedances of the 8-hour CO NAAQS decreased by 43 percent between 1989 and 1990 at these 359 sites. Estimated nationwide CO emissions decreased less than one percent between 1989 and 1990. The 7 percent reduction in CO emissions from highway vehicles was offset by the increase in forest fire emissions in Alaska.

Figure 3-23 shows the composite Regional averages for the 1988-90 time period. Every Region, except Region I, has 1990 composite mean levels less than the corresponding 1988 and 1989 values. These Regional graphs are primarily intended to depict relative change. Because the mix of monitoring sites may vary from one area to another, this graph is not intended to indicate Regional differences in concentration levels.

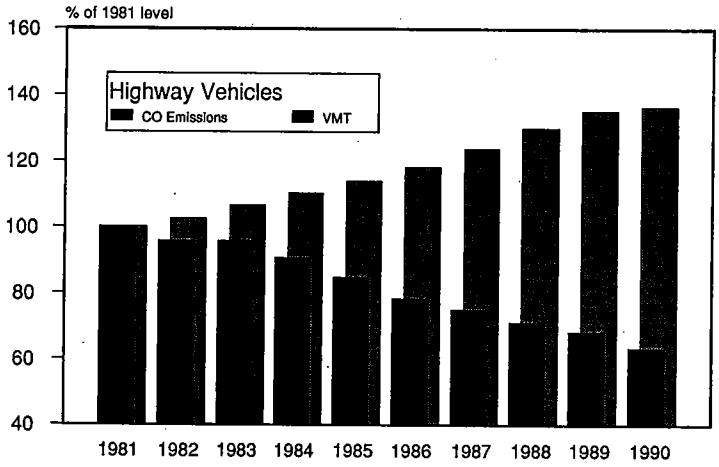

Figure 3-22. Comparison of trends in total national vehicle miles traveled and national highway vehicle emissions, 1981-1990.

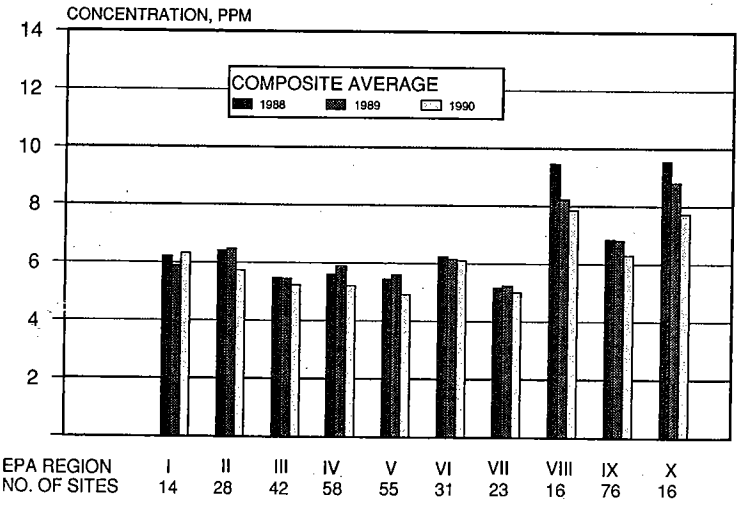

Figure 3-23. Regional comparisons of 1988, 1989, 1990 composite averages of the second highest nonoverlapping 8-hour average carbon monoxide concentrations.

3.4 TRENDS IN NITROGEN DIOXIDE

Nitrogen dioxide (NO_2) is a yellowish brown, highly reactive gas which is present in urban atmospheres. The major mechanism for the formation of NO_2 in the atmosphere is the oxidation of the primary air pollutant, nitric oxide (NO). Nitrogen oxides play a major role, together with volatile organic compounds, in the atmospheric reactions that produce ozone. Nitrogen oxides form when fuel is burned at high temperatures. The two major emissions sources are transportation and stationary fuel combustion sources such as electric utility and industrial boilers.

Nitrogen dioxide can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections. Nitrogen oxides are an important precursor both to ozone and acidic precipitation and may affect both terrestrial and aquatic ecosystems. Los Angeles, CA is the only urban area that has recorded violations of the annual average NO_2 standard of 0.053 ppm during the past 10 years.

NO_2 is measured using a continuous monitoring instrument which can collect as many as 8760 hourly observations per year. Only annual means based on at least 4380 hourly observations were considered in the trends analyses which follow. A total of 166 sites were selected for the 10-year period and 211 sites were selected for the 3-year data base.

3.4.1 Long-term NO_2 Trends: 1981-90

The composite average long-term trend for the nitrogen dioxide mean concentrations at the 166 trend sites and the 42 NAMS sites, is shown in Figure 3-24. The 95 percent confidence intervals about the composite means reveal that the 1981-89 NO_2 levels are statistically indistinguishable. The 1990 composite average NO_2 level is 8 percent lower than the 1981 level, and the difference is statistically significant. A similar trend is seen for the NAMS sites which, for NO_2, are located only in large urban areas with populations of one million or

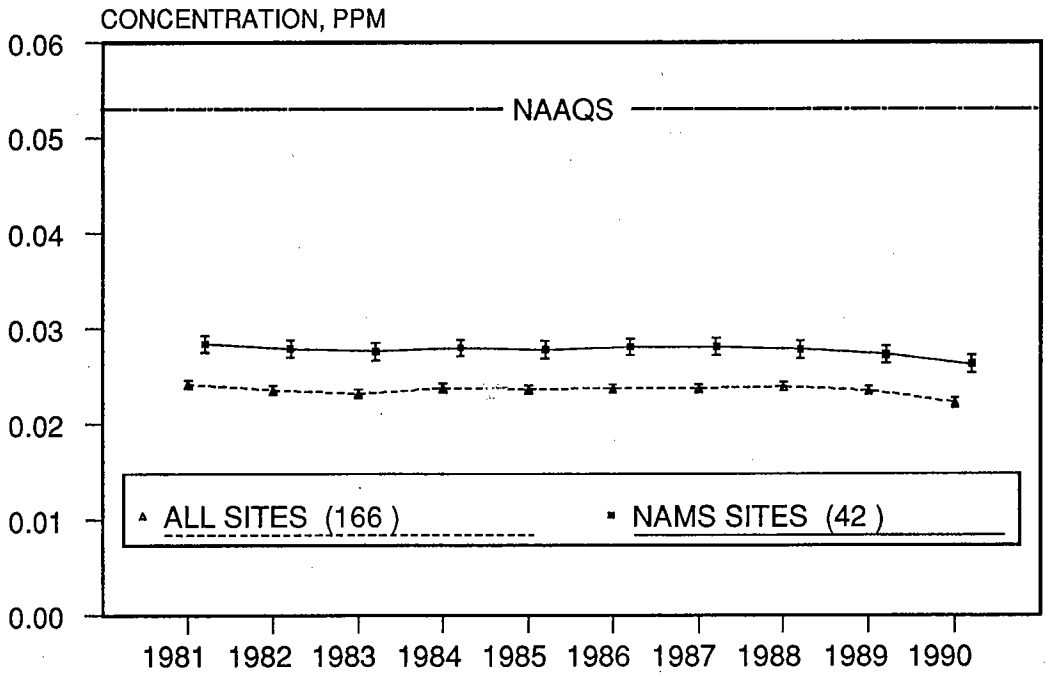

Figure 3-24. National trend in the composite annual average nitrogen dioxide concentration at both NAMS and all sites with 95 percent confidence intervals, 1981-1990.

greater. As expected, the composite averages of the NAMS are higher than those of all sites, however, they also recorded a statistically significant decrease of 8 percent during this period.

Long-term trends in NO_2 annual average concentrations are also displayed in Figure 3-25 with the use of boxplots. The middle quartiles for the years 1981 through 1989 are similar, while a decrease in levels can be seen in 1990. The upper percentiles, which generally reflect NO_2 annual mean levels in the Los Angeles metropolitan area, also show improvement during the last three years. The lower percentiles show little change, however. Last year's report presented long-term NO_2 annual mean trends among metropolitan areas of varying population size. The level of the NO_2 composite means varied by metropolitan area size, with the larger areas recording the higher concentration levels.

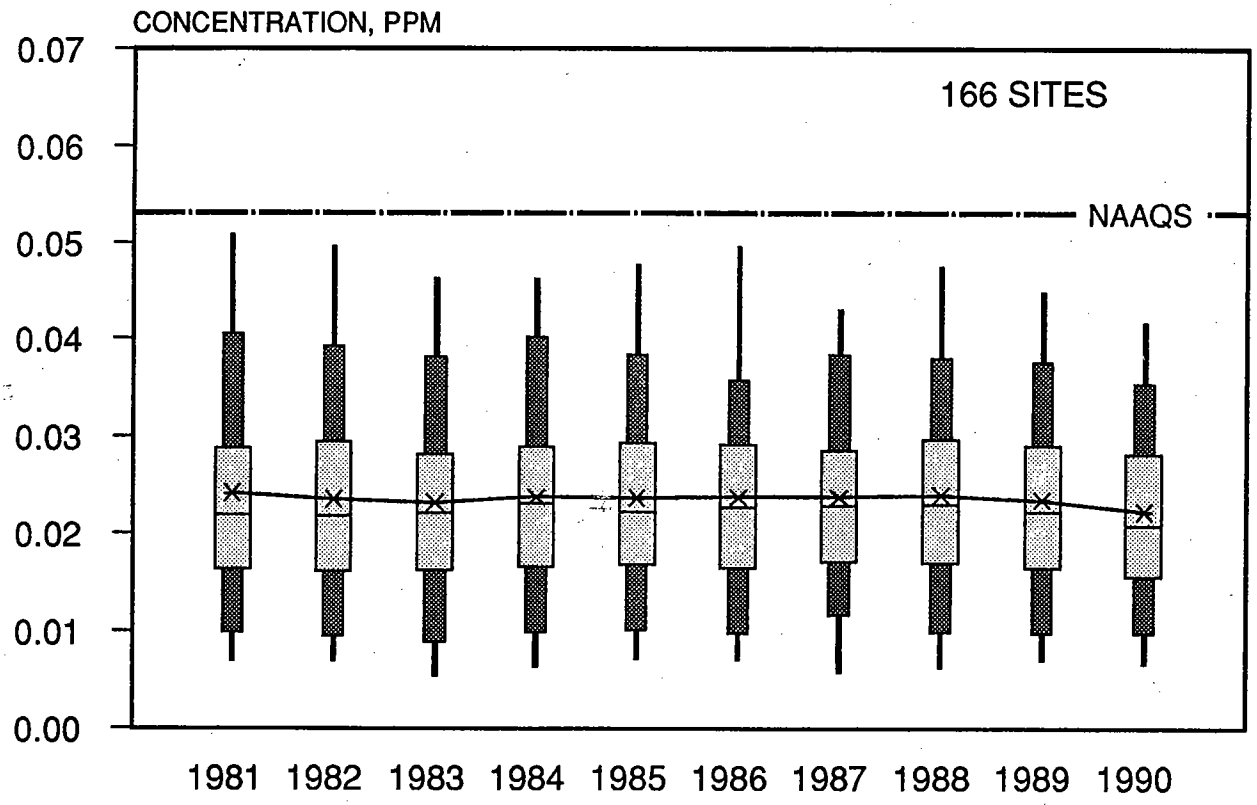

Figure 3-25. Boxplot comparisons of trends in annual mean nitrogen dioxide concentrations at 166 sites, 1981-1990.

Table 3-6 presents the trend in estimated nationwide emissions of nitrogen oxides (NO_x). The decreasing trend in NO_x emissions from 1981 through 1983 was reversed in 1984. The decline in NO_x nationwide emissions between 1985 and 1986 has been followed by increased NO_x emissions in 1987 and 1988. However, total 1990 nitrogen oxides emissions are 6 percent less than 1981 emissions. Highway vehicle emissions decreased by 30 percent during this period, while fuel combustion emissions have recorded yearly increases during the last 4 years. Most of the decreases in mobile source emissions occurred in urban areas, while much of the increases in stationary source emissions occurred at facilities located outside these urbanized areas. Figure 3-26 shows that the two primary source categories of nitrogen oxides emissions are fuel combustion and transportation, composing 57 percent and 38 percent, respectively, of total 1990 nitrogen oxides emissions.

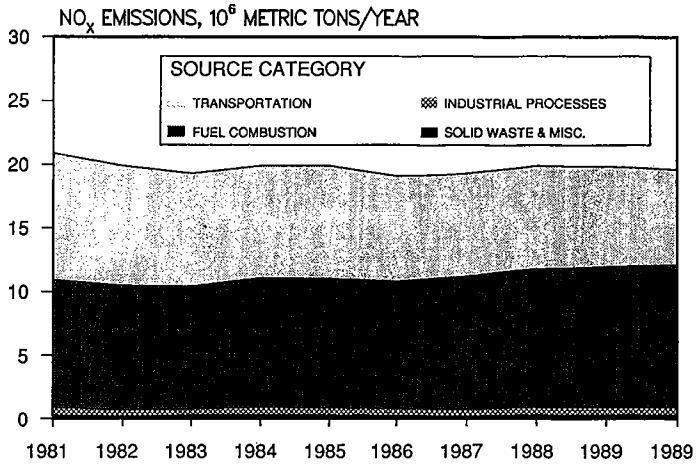

Figure 3-26. National trend in nitrogen oxides emissions, 1981-1990.

TABLE 3-6. National Nitrogen Oxides Emission Estimates, 1981-1990

	(million metric tons/year)									
SOURCE CATEGORY	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Transportation	9.9	9.4	8.9	8.8	8.9	8.3	8.1	8.1	7.9	7.5
Fuel Combustion	10.0	9.8	9.6	10.2	10.2	10.0	10.5	10.9	11.1	11.2
Industrial Processes	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Solid Waste	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Miscellaneous	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.3
TOTAL	20.9	20.0	19.4	19.8	19.9	19.1	19.4	20.0	19.8	19.6

NOTE: The sums of sub-categories may not equal total due to rounding.

3.4.2 Recent NO_2 Trends: 1988-1990

Between 1989 and 1990, the composite annual mean NO_2 concentration at 211 sites, with complete data during the last three years, decreased by 6 percent, the largest decline in recent years. At the subset of 47 NAMS, the composite mean concentration decreased 5 percent between 1989 and 1990. Nationwide emissions of nitrogen oxides are estimated to have decreased 1 percent between 1989 and 1990.

Regional trends in the composite average NO_2 concentrations for the years 1988-90 are displayed in Figure 3-27 with bar graphs. Region X, which did not have any NO_2 sites meeting the 3-year data completeness and continuity criteria, is not shown. All of the remaining nine Regions have 1990 composite average NO_2 annual mean concentrations that are lower than the previous two years 1988 and 1989. Seven of the nine Regions have 1989 composite mean concentrations which are lower than the corresponding 1988 levels. These Regional graphs are primarily intended to depict relative change. Because the mix of monitoring sites may vary from one area to another, this graph is not intended to indicate Regional differences in absolute concentration levels.

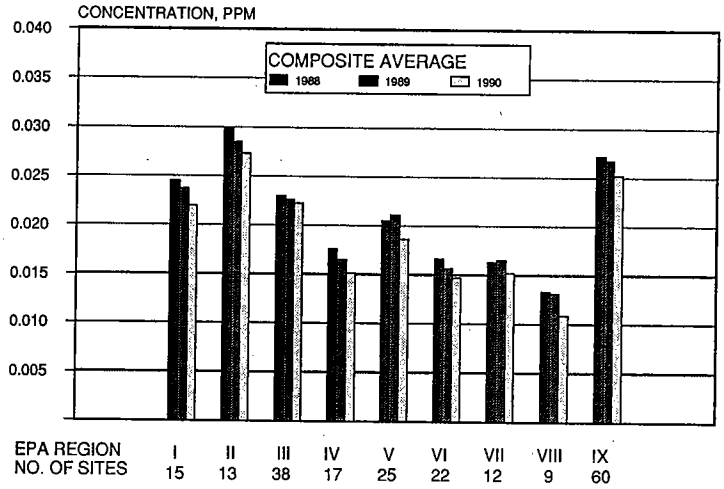

Figure 3-27. Regional comparisons of 1988, 1989, 1990 composite averages of the annual mean nitrogen dioxide concentrations.

3.5 TRENDS IN OZONE

Ozone (O_3) is a photochemical oxidant and the major component of smog. While ozone in the upper atmosphere is beneficial to life by shielding the earth from harmful ultraviolet radiation from the sun, high concentrations of ozone at ground level are a major health and environmental concern. Ozone is not emitted directly into the air but is formed through complex chemical reactions between precursor emissions of volatile organic compounds and nitrogen oxides in the presence of sunlight. These reactions are stimulated by sunlight and temperature so that peak ozone levels occur typically during the warmer times of the year. Both volatile organic compounds and nitrogen oxides are emitted by transportation and industrial sources. Volatile organic compounds are emitted from sources as diverse as autos, chemical manufacturing, and dry cleaners, paint shops and other sources using solvents. Nitrogen oxides emissions were discussed in Section 3.4.

The reactivity of ozone causes health problems because it tends to break down biological tissues and cells. Recent scientific evidence indicates that ambient levels of ozone not only affect people with impaired respiratory systems, such as asthmatics, but healthy adults and children, as well. Exposure to ozone for several hours at relatively low concentrations has been found to significantly reduce lung function in normal, healthy people during exercise. This decrease in lung function generally is accompanied by symptoms including chest pain, coughing, sneezing and pulmonary congestion.

The O_3 NAAQS is defined in terms of the daily maximum, that is, the highest hourly average for the day, and it specifies that the expected number of days per year with values greater than 0.12 ppm should not be greater than one. Both the annual second highest daily maximum and the number of daily exceedances during the ozone season are considered in this analysis. The strong seasonality of ozone levels makes it possible for areas to limit their ozone monitoring to a certain portion of the year, termed the ozone season. The length of the ozone season varies from one area of the country to another. May through October is typical but States in the south and southwest may monitor the entire year. Northern States would have shorter ozone seasons such as May through September for

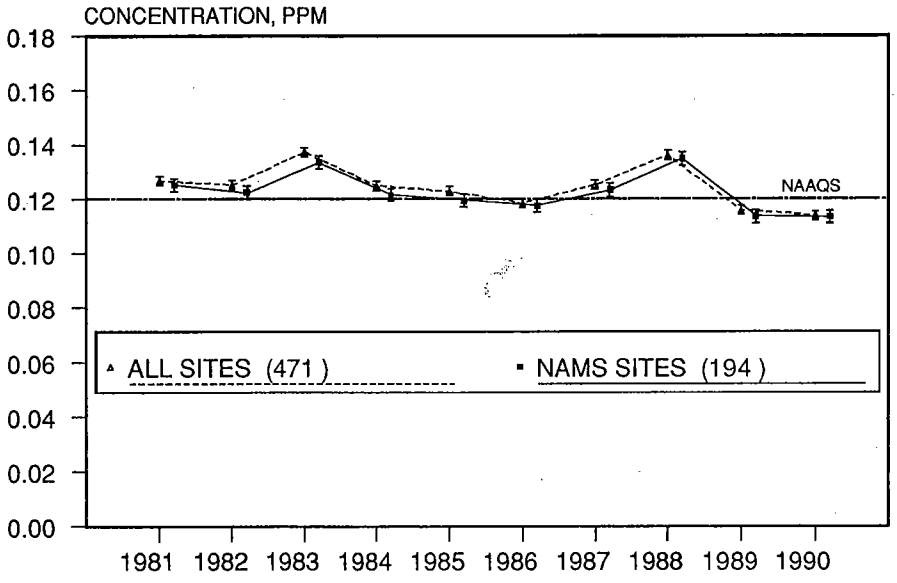

Figure 3-28. National trend in the composite average of the second highest maximum 1-hour ozone concentration at both NAMS and all sites with 95 percent confidence intervals, 1981-1990.

North Dakota. This analysis uses these ozone seasons to ensure that the data completeness requirements apply to the relevant portions of the year.

The trends site selection process, discussed in Section 2.1, resulted in 471 sites being selected for the 1981-90 period, an increase of 40 sites (or 9%) from the 1980-89 trends data base. A total of 590 sites are included in the 1988-90 data base. The NAMS compose 194 of the long-term trends sites and 206 of the sites in the 3-year data base.

3.5.1 Long-term O_3 Trends: 1981-90

Figure 3-28 displays the 10-year composite average trend for the second highest day during the ozone season for the 471 trends sites and the subset of 194 NAMS sites. The 1990 composite average for the 471 trend sites is 10 percent lower than the 1981 average and 9 percent lower for the subset of 194 NAMS. These 1990 values are the lowest composite averages of the past ten years. The 1990 composite average is significantly less than the 1988 composite mean, which is the second highest average (1983 was the highest) during this 10-year period. The relatively high ozone concentrations in both 1983 and 1988 are likely attributed in part to hot, dry, stagnant conditions in some areas of the country that were more conducive to ozone formation than other years. Peak ozone concentrations typically occur during hot, dry, stagnant summertime conditions (high temperature and strong solar insolation).[10,11] Previous reports have compared the regional variability in meteorological parameters such as maximum daily temperature and precipitation with the variability in peak ozone concentrations.[6]

The interpretation of recent ozone trends is difficult due to the confounding factors of meteorology and emission changes. Just as the increase in 1988 is attributed in part to meteorological conditions, the 1989 decrease is

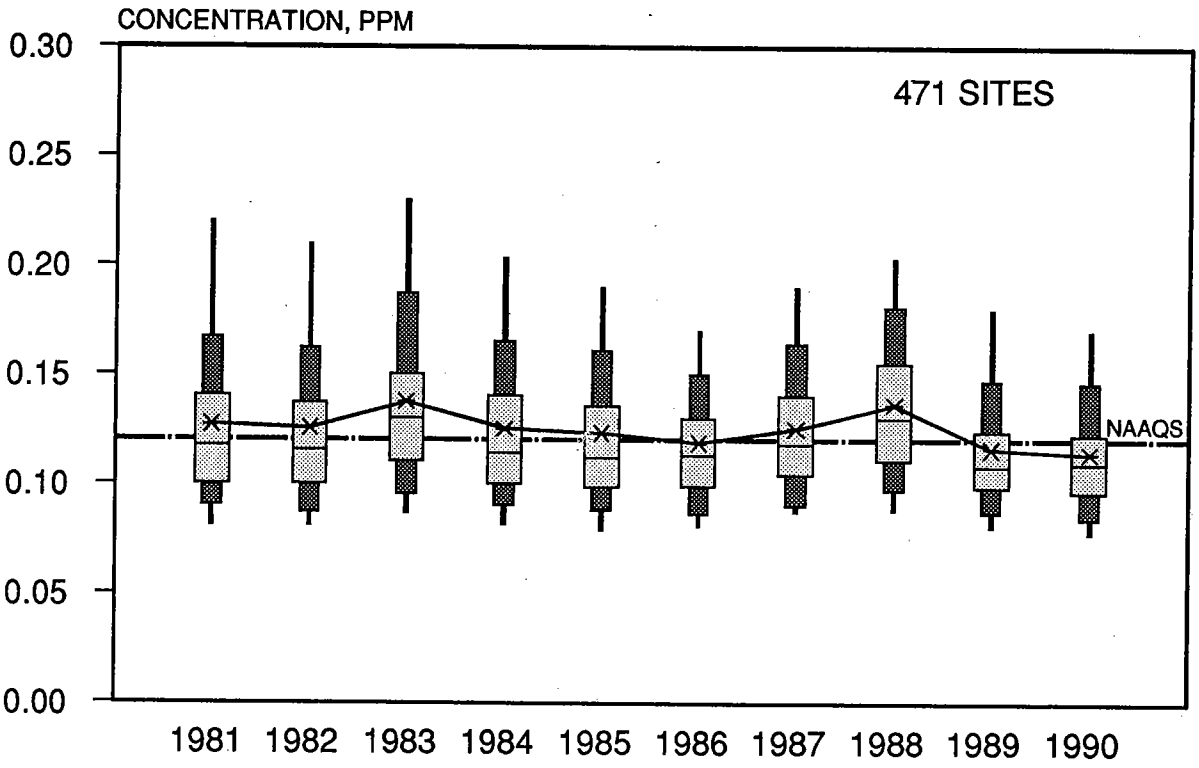

Figure 3-29. Boxplot comparisons of trends in annual second highest daily maximum 1-hour ozone concentration at 471 sites, 1981-1990.

likely due, in part, to meteorological conditions being less favorable for ozone formation in 1989 than in 1988. This pattern was followed by summer 1990 which nationally was warmer and drier than the long-term climatological means. Also, precursor emissions of nitrogen oxides and volatile organic compound emissions from highway vehicles have decreased in urban areas. The volatility of gasoline was reduced by new regulations which lowered national average summertime Reid Vapor Pressure (RVP) in regular unleaded gasoline from 10.0 to 8.9 pounds per square inch (psi) between 1988 and 1989.[12,13,14] RVP was reduced an additional 3 percent between 1989 and 1990.[15]

The inter-site variability of the annual second highest daily maximum concentrations for the 471 site data base is displayed in Figure 3-29. The years 1983 and 1988 values are similarly high, while the remaining years in the 1981-90 period are generally lower, with 1990 being the lowest, on average. The distribution of second daily maximum 1-hour concentrations in 1990 is similar to that recorded in 1989 and 1986. Figure 3-30 depicts the 1981-90 trend for the composite average number of ozone exceedances. This statistic is adjusted for missing data, and it reflects the number of days that the ozone standard is exceeded during the ozone season. Since 1981, the expected number of exceedances decreased 51 percent for both the 471 long-term trend sites and the subset of 194 NAMS. As with the second maximum, the 1983 and 1988 values are higher than the other years in the 1981-90 period. The 1989 and 1990 levels are significantly lower than all the previous years.

Table 3-7 and Figure 3-31 display the 1981-90 emission trends for volatile organic compounds (VOC) which, along with nitrogen oxides, are involved in the atmospheric chemical and physical processes that result in the formation of O_3. Total VOC emissions are estimated to have decreased 12 percent between 1981 and 1990. Between 1981 and 1990, VOC emissions from highway vehicles decreased 34 percent, despite a 37 percent increase in vehicle miles of travel during this time period (see Figure 3-21). Previously, VOC emissions from highway vehicles were estimated using nationwide annual temperatures and nationwide average RVP. Starting with last year's report, these VOC estimates for the 10-year period are now based on statewide average monthly temperatures and statewide average RVP.

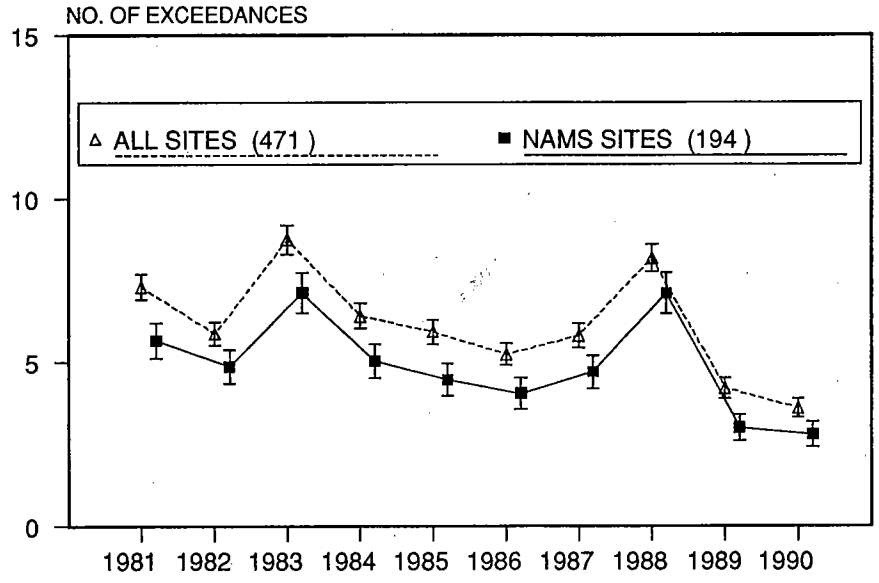

Figure 3-30. National trend in the estimated number of daily exceedances of the ozone NAAQS in the ozone season at both NAMS and all sites with 95 percent confidence intervals, 1981-1990.

The highway vehicle emission estimates for the years 1989 and 1990 were calculated using 1988 RVP data, the last year for which statewide figures were available. Thus, the reductions in average summertime RVP levels that have occurred since 1988 are not reflected in the emissions totals for transportation sources. The increase in VOC emissions between 1989 and 1990 is due to VOC emissions from forest fires in Alaska, which are not likely to have contributed to ozone formation in urban areas. These VOC emissions estimates represent annual totals. While these are the best national numbers now available, ozone is predominately a warm weather problem and seasonal emission trends would be preferable.

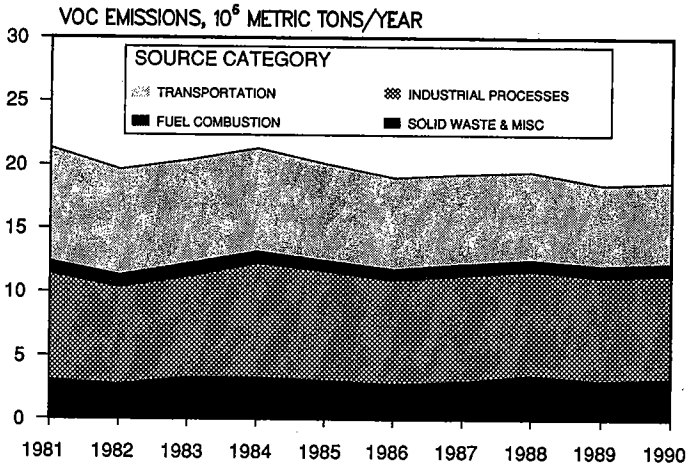

Figure 3-31. National trend in volatile organic compound emissions, 1981-1990.

TABLE 3-7. National Volatile Organic Compound Emission Estimates, 1981-1990

(million metric tons/year)

SOURCE CATEGORY	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Transportation	8.9	8.3	8.2	8.1	7.6	7.2	7.1	6.9	6.4	6.4
Fuel Combustion	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9
Industrial Processes	8.3	7.5	7.9	8.9	8.5	8.0	8.3	8.1	8.1	8.1
Solid Waste	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Miscellaneous	2.4	2.1	2.7	2.6	2.5	2.2	2.4	2.9	2.5	2.7
TOTAL	21.3	19.6	20.4	21.2	20.1	19.0	19.3	19.4	18.5	18.7

NOTE: The sums of sub-categories may not equal total due to rounding.

3.5.2 Recent O_3 Trends: 1988-1990

This section discusses ambient O_3 changes during the 3-year time period 1988-90. Using this 3-year period permits the use of a larger data base of 590 sites, compared to 471 for the 10-year period.

Nationally, 1988 was the third hottest summer since 1931, with hot, dry meteorological conditions experienced in much of the Eastern U.S. during the summer.[16] In the East, the period from January through July 1989 was among the wettest on record in nine states.[17] Summer 1990 temperature averaged across the nation was above the long-term mean and ranks as the 15th warmest summer on record since 1895.[18] Spatially averaged 1990 precipitation was below the long-term mean and ranks as the 29th driest summer. Regionally, the Central and East North Central had average summer temperatures, with other regions above normal. During the summer of 1990, the South and Southeast were unusually dry, while the Northeast, East, North Central and Northwest Regions had above average precipitation.[18] Also, 1990 average RVP decreased 3 percent from summer 1989 levels, and 1989 was 11 percent lower than 1988 average RVP.[15]

Between 1989 and 1990, composite mean ozone concentrations decreased 1 percent at the 590 sites and by less than 1 percent at the subset of 206 NAMS. The 1990 composite average is 17 percent lower than the 1988 composite mean for these 590 sites. Between 1989 and 1990, the composite average of the number of estimated exceedances of the ozone standard decreased by 17 percent at the 590 sites, and 14 percent at the 206 NAMS. Because of forest fires in Alaska, nationwide VOC emissions increased 1 percent between 1989 and 1990. There was a 4 percent decrease between 1988 and 1990.

The composite average of the second daily maximum concentrations decreased in every Region of the nation between 1988 and 1989. As Figure 3-32 indicates, the largest decreases were recorded in the northeastern states, composing EPA Regions I through III. Except for the northwest (Region X) when 1990 was the peak year, every region recorded its highest composite mean for this 3-year period in 1988. Five Regions had 1990 composite averages lower than 1989 levels, while the remaining five Regions had 1990 composite averages lower than 1988 and 1989.

These Regional graphs are primarily intended to depict relative change. Because the mix of monitoring sites may vary from one area to another, this graph is not intended to indicate Regional differences in absolute concentration levels.

Previous reports have presented a preliminary estimate of the trend in the composite average of the second highest daily maximum 1-hour ozone concentration. These estimates were based on preliminary, unvalidated data that were reported to EPA about 3 months ahead of the schedule typically required for quality assurance and data submittal. The accelerated printing schedule for this year's report precluded an advanced estimate for 1991, because sufficient 1991 data were not available as the report went to press.

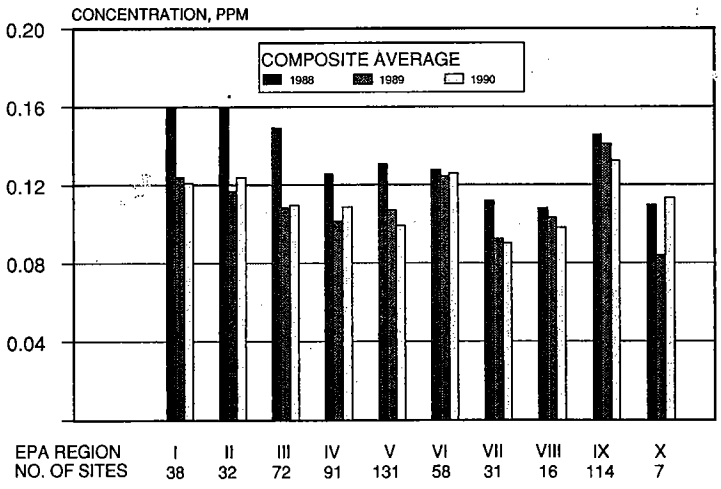

Figure 3-32. Regional comparisons of the 1988, 1989, 1990 composite averages of the second-highest daily 1-hour ozone concentrations.

3.6 TRENDS IN LEAD

Lead (Pb) gasoline additives, nonferrous smelters and battery plants are the most significant contributors to atmospheric Pb emissions. Transportation sources in 1990 contributed 31 percent of the annual emissions, down substantially from 73 percent in 1985. Total lead emissions from all sources dropped from 20.1 x 10^3 metric tons in 1985 to 7.2 x 10^3 and 7.1 x 10^3 metric tons, respectively in 1989 and 1990. The decrease in lead emissions from highway vehicles accounts for essentially all of this drop. The reasons for this drop are noted below.

Two air pollution control programs implemented by EPA before promulgation of the Pb standard in October 1978[19] have resulted in lower ambient Pb levels. First, regulations issued in the early 1970s required gradual reduction of the Pb content of all gasoline over a period of many years. More recently, the Pb content of the leaded gasoline pool was reduced from an average of 1.0 grams/gallon to 0.5 grams/gallon on July 1, 1985 and still further to 0.1 grams/gallon on January 1, 1986. Second, as part of EPA's overall automotive emission control program, unleaded gasoline was introduced in 1975 for use in automobiles equipped with catalytic control devices. These devices reduce emissions of carbon monoxide, volatile organics and nitrogen oxides. In 1990, unleaded gasoline sales accounted for 89 percent of the total gasoline market. These programs have essentially eliminated violations of the lead standard in urban areas, except in those areas with lead point sources. Programs are also in place to control Pb emissions from stationary point sources. Pb emissions from stationary sources have been substantially reduced by control programs oriented toward attainment of the particulate matter and Pb ambient standards, however, significant ambient problems still remain around some lead point sources. Lead emissions in 1990 from industrial sources, e.g. primary and secondary lead smelters, dropped by more than one-half from levels reported in the late 70s. Emissions of lead from solid waste disposal are down 45 percent since the late 70s. In 1990, emissions from solid waste disposal and industrial processes and transportation were each estimated to be 2.2 x 10^3 metric tons. The overall effect of these three control programs has been a major reduction in the amount of Pb in the ambient air. In addition to the above Pb pollution reduction activities, additional reductions in Pb are anticipated as result of the Agency's Multi-media Lead Strategy issued in February, 1991.[20] The goal of the Agency's Lead Strategy is to reduce Pb exposures to the fullest extent practicable.

Exposure to lead can occur through multiple pathways, including inhalation of air, diet and ingestion of lead in food, water, soil or dust. Excessive lead exposure can cause seizures, mental retardation and/or behavioral disorders. Fetuses, infants and children are especially susceptible to low doses of lead, resulting in central nervous system damage. Recent studies have also shown that lead may be a factor in high blood pressure and subsequent heart disease in middle-aged white males.

3.6.1 Long-term Pb Trends: 1981-90

Early trend analyses of ambient Pb data[21,22] were based almost exclusively on National Air Surveillance Network (NASN) sites. These sites were established in the 1960's to monitor ambient air quality levels of TSP and associated trace metals, including Pb. The sites were predominantly located in the central business districts of larger American cities. In September 1981, ambient Pb monitoring regulations were promulgated.[23] The siting criteria in the regulations resulted in finding many of the old historic TSP monitoring sites unsuitable for the measurement of ambient Pb concentrations and many of the earlier sites were moved or discontinued.

As with the other pollutants, the sites selected for the long-term trend analysis had to satisfy annual data completeness criteria of at least 8 out of 10 years of data in the 1981 to 1990 period. A year was included as "valid" if at least 3 of the 4 quarterly averages were available. As in last year's report, composite lead data, i.e., individual 24-hour observations are composited together by month or quarter and a single analysis made, are being used in the trend analysis. Fifteen sites qualified for the 10-year trend because of the addition of composite

data. A total of 202 urban-oriented sites, from 38 States and Puerto Rico, met the data completeness criteria. Sixty-four of these sites were NAMS, the largest number of lead NAMS sites to qualify for the 10-year trends. Thirty-two (16 percent) of the 202 trend sites were located in the State of California, thus this state is over-represented in the sample of sites satisfying the long-term trend criteria. However, the lead trend at the California sites was almost identical to the trend at the non-California sites; so that these sites did not distort the overall trends. Other states with 10 or more trend sites included: Illinois (23), Kansas (16), Pennsylvania (11), West Virginia (10) and Texas (10). Again, the Pb trend in each of these states was very similar to the national trend. Sites that were located near lead point sources such as primary and secondary lead smelters were excluded from the urban trend analysis, because the magnitude of the levels at these sources could mask the underlying urban trends. Trends at lead point source oriented sites will be discussed separately in the next section.

The means of the composite maximum quarterly averages and their respective 95 percent confidence intervals are shown in Figure 3-33 for both the 202 urban sites and 64 NAMS sites (1981-1990). There was an 85 percent (1981-90) decrease in the average for the 202 urban sites. Lead emissions over this 10-year period also decreased. There was an 87 percent decrease in total lead emissions and a 95 percent decrease in lead emissions from transportation sources. The confidence intervals for all sites indicate that the 1985-90 averages are significantly less than all averages from preceding years. Because of the smaller number (64) of NAMS sites with at least 8 years of data, the confidence intervals are wider. However, the 1985-90 NAMS averages are still significantly different from all NAMS averages before 1985. It

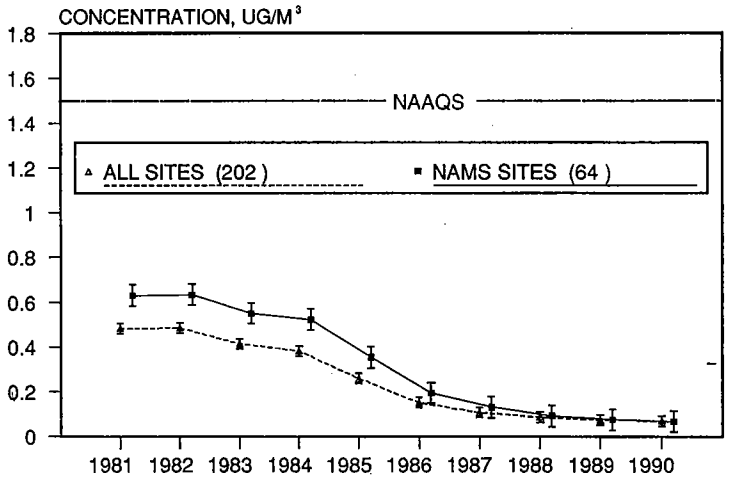

Figure 3-33. National trend in the composite average of the maximum quarterly average lead concentration at both NAMS and all sites with 95 percent confidence intervals, 1981-1990.

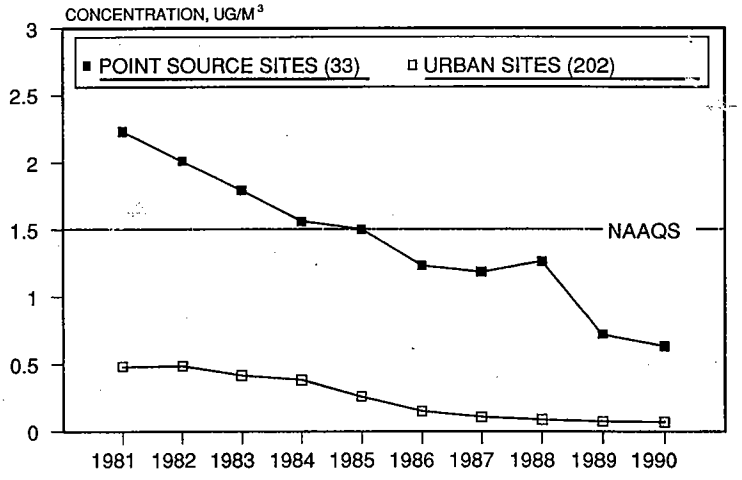

Figure 3-34. Comparison of national trend in the composite average of the maximum quarterly average lead concentrations at urban and point-source oriented sites, 1981-1990.

is interesting to note that the composite average lead concentration at the NAMS sites in 1990 is essentially the same (0.068 $\mu g/m^3$) as the "all sites" average; whereas in the early 1980's the averages of the NAMS sites were significantly higher. Figure 3-34 shows the trend in average lead concentrations for the urban-oriented sites and for 33 point-source oriented sites which met the 10-year data completeness criteria. Composite average ambient lead concentrations at the point-source oriented sites, located near industrial sources of lead, e.g. smelters, battery plants, improved 72%, compared to 85% at the urban oriented sites. The average at the point-source oriented sites dropped in magnitude from 2.2 to 0.6 $\mu g/m^3$, a 1.6 $\mu g/m^3$ difference; whereas, the average at the urban sites dropped only from 0.5 to 0.1 $\mu g/m^3$. This improvement at the point-source oriented sites reflects both industrial and automotive lead emission controls, but in some cases, the industrial source reductions are because of plant shutdowns. However, there are still several urban areas where significant Pb problems persist. The 10 MSAs shown in Table 4-3 that are above the lead NAAQS in 1990 are all due to lead point sources. These MSAs are Birmingham, AL; Columbus, GA-AL; Dallas, TX; Indianapolis, IN; Memphis, TN; Minneapolis, MN; Nashville, TN; Omaha, NE-IA; Philadelphia, PA; and St Louis, MO-IL. Figure 3-35 shows boxplot comparisons of the maximum quarterly average Pb concentrations at the 202 urban-oriented Pb trend sites (1981-90). This figure shows the dramatic improvement in ambient Pb concentrations over the entire distribution of trend sites. As with the composite average concentration since 1981, most of the percentiles also show a monotonically decreasing pattern. The 202 urban-oriented sites that qualified for the 1981-90 period, when compared to the 189 sites for 1980-89 and the 139 sites for 1979-88 period,[6,16] indicate a substantial expansion of the 10-year trends data base.

The trend in total lead emissions is shown in Figure 3-36. Table 3-8 summarizes the Pb emissions data as well. The 1981-90 drop in total Pb emissions was 87 percent. Lead emissions in the transportation category account for most of this drop. The trend in Pb emissions from non-transportation sources is shown in Figure 3-37. This figure shows the trend in two categories: industrial and the total of all non-transportation sources. Lead emissions from both of these categories show a drop early in the time period with a leveling off thereafter. The drop in the non-transportation emissions is due to decreases in

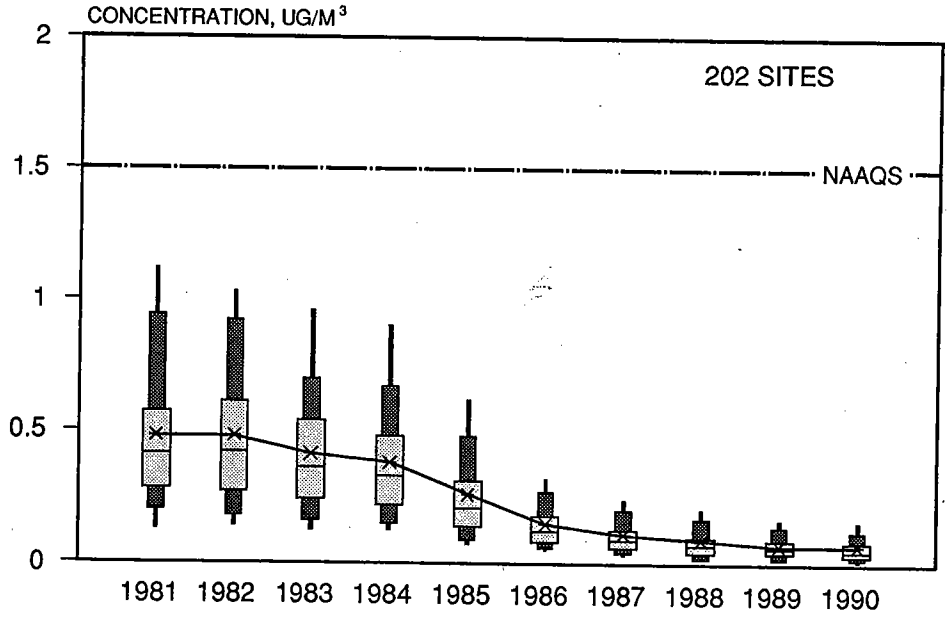

Figure 3-35. Boxplot comparisons of trends in maximum quarterly average lead concentrations at 202 sites, 1981-1990.

lead from all categories as shown in Table 3-8. This compares with the 85 percent decrease (1981-90) in ambient lead concentrations. The drop in Pb consumption and subsequent Pb emissions since 1981 was brought about by the increased use of unleaded gasoline in catalyst-equipped cars and the reduced Pb content in leaded gasoline. The results of these actions in 1990 amounted to a 65 percent reduction nationwide in total Pb emissions from 1985 levels. As noted previously, unleaded gasoline represented 89 percent of 1990 total gasoline sales. Although the good agreement among the trend in lead consumption, emissions and ambient levels is based upon a limited geographical sample, it does show that ambient urban Pb levels are responding to the drop in lead emissions.

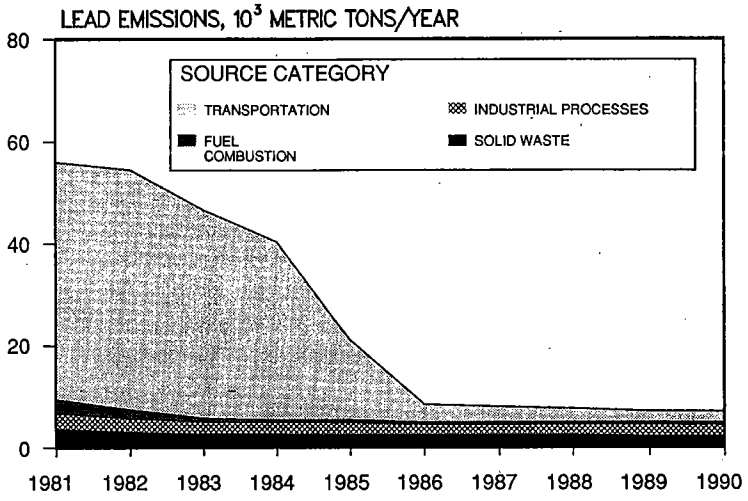

Figure 3-36. National trend in lead emissions, 1981-1990.

TABLE 3-8. National Lead Emission Estimates, 1981-1990

(thousand metric tons/year)

SOURCE CATEGORY	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Transportation	46.5	47.0	40.8	34.7	14.7	3.5	3.0	2.6	2.2	2.2
Fuel Combustion	2.8	1.7	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Industrial Processes	3.0	2.7	2.4	2.3	2.3	1.9	1.9	2.0	2.3	2.2
Solid Waste	3.7	3.1	2.7	2.7	2.6	2.6	2.6	2.5	2.3	2.2
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	56.0	54.5	46.6	40.2	20.1	8.4	8.0	7.6	7.2	7.1

NOTE: The sums of sub-categories may not equal total due to rounding.

In Canada a very similar trend in ambient lead concentrations has been observed. Declines in composite average lead concentrations of 86 percent were found for the 1980-89 time period.[24] Also, average ambient Pb concentrations in Tokyo, Japan[25] have dropped from around 1.0 $\mu g/m^3$ in 1967 to approximately 0.1 $\mu g/m^3$ in 1985 - a 90% improvement.

3.6.2 Recent Pb Trends: 1988-90

Ambient Pb trends were also studied over the shorter period 1988-90. A total of 229 urban sites from 37 States and Puerto Rico met the data requirement that a site have all 3 years with data. In recent years, the number of lead sites has dropped because of the elimination of some TSP monitors from state and local air monitoring programs. Some monitors were eliminated due to the change in the particulate matter standard from TSP to PM-10 while others were discontinued because of the very low lead concentrations measured in many urban locations. Although some further attrition may occur, the core network of NAMS lead sites together with supplementary State and local sites should be sufficient to access national ambient lead trends. The 3-year data base (1988-90) showed an improvement of 26 percent in composite average urban Pb concentrations. The 1988 and 1990 lead averages respectively were 0.087 and 0.064 $\mu g/m^3$, a 26 percent improvement. This corresponds to reductions in total Pb emissions of 7 percent and a reduction of 15 percent in lead emissions from transportation sources. Most of this decrease in total nationwide Pb emissions was due once again to the decrease in automotive Pb emissions. Even this larger group of sites was disproportionately weighted by sites in California, Illinois, Kansas and Texas. These States had about 35 percent of the 229 sites represented. However, the percent changes in

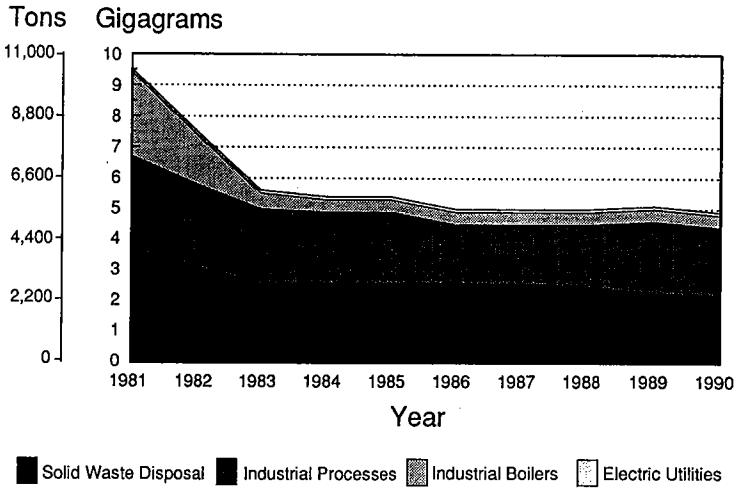

Figure 3-37. National trend in emissions of lead excluding transportation sources, 1981 - 1990.

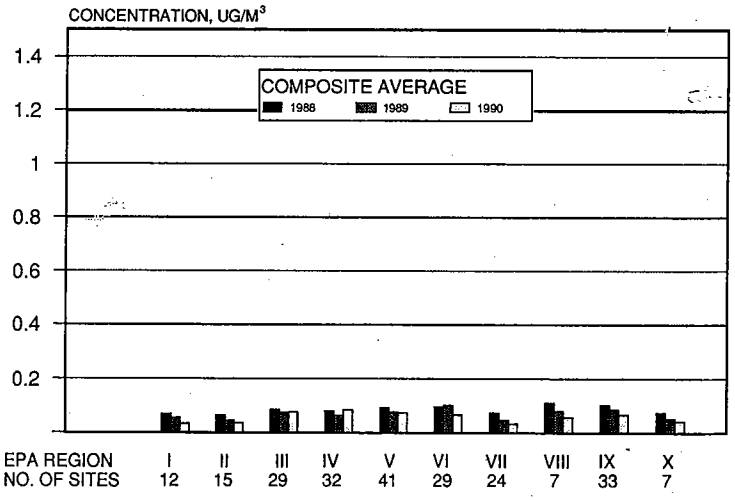

Figure 3-38. Regional comparison of the 1988, 1989, 1990 composite average of the maximum quarterly average lead concentrations.

1988-90 average Pb concentrations for these four States were very similar to the percent change for the remaining sites, thus the contributions of these sites did not distort the national trends. Although urban lead concentrations continue to decline consistently, there are indications that the rate of the decline has slowed down. Clearly in some areas, urban lead levels are so low, that further improvements have become difficult.

Indeed, as will be shown later, all sections of the country are showing declines in average lead concentrations. Sixty-three (63) point source oriented sites showed an average drop of 36 percent over the 1988-90 time period. Thus, this decrease in ambient lead concentrations near lead point sources has been slightly more pronounced than in urban areas. The average lead levels at these sites are much higher here than at the urban sites. The 1989 and 1990 lead point source averages were 0.79 and 0.80 $\mu g/m^3$ respectively.

The larger sample of sites represented in the 3-year trends (1988-90) will be used to compare the most recent individual yearly averages. However, for the 10-year time period the largest single year drop in average lead concentrations, 42 percent, occurs as expected between 1985 and 1986, because of the shift of the lead content in leaded gasoline. The 1990 composite average lead concentrations show the more modest decline of 12 percent from 1989 levels. The 10-year data base showed a 5 percent decrease in average lead concentrations from 1989 to 1990. There has been no change in estimated Pb emissions for the transportation category between 1989 and 1990. Although, VMT increased 1 percent between 1989 and 1990. The Pb emissions trend is expected to continue downward, but at a slower rate, primarily because the leaded gasoline market will continue to shrink. Between 1989 and 1990, total lead emissions decreased 1 percent, while emissions from transportation sources remained unchanged. Some major petroleum companies have discontinued refining leaded gasoline because of the dwindling market, so that in the future the consumer will find it more difficult to purchase regular leaded gasoline. Figure 3-38 shows 1988, 1989 and 1990 composite average Pb concentrations, by EPA Region. Once again the larger more representative 3-year data base of 229 sites was used for this comparison. The number of sites varies dramatically by Region from 7 in Regions VIII and X to 41 in Region V. In all Regions, except Region IV, there is a decrease in average Pb urban concentrations between 1988 and 1990. These results confirm that average Pb concentrations in urban areas are continuing to decrease throughout the country, which is exactly what is to be expected because of the national air pollution control program in place for Pb.

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4. AIR QUALITY STATUS OF METROPOLITAN AREAS, 1990

This chapter provides general information on the current air quality status of metropolitan areas[1] within the United States. Four different summaries are presented in the following sections. First, maps depicting the areas designated nonattainment for the National Ambient Air Quality Standards (NAAQS) for particulate matter (PM-10), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3) and lead (Pb) are presented. Next, an estimate is provided of the number of people living in counties which did not meet the NAAQS based on only 1990 air quality data. (Note that nonattainment designations typically involve multi-year periods.) Third, pollutant-specific maps are presented to provide the reader with a geographical view of how peak 1990 air quality levels varied throughout the 90 largest Metropolitan Statistical Areas (MSAs) in the continental United States. Finally, the peak pollutant-specific statistics are listed for each MSA with 1990 air quality monitoring data.

Table 4-1. Nonattainment Areas for NAAQS Pollutants as of October 1991

Pollutant	Number of Nonattainment Areas
Particulate Matter (PM-10)	70
Sulfur Dioxide (SO_2)	50
Carbon Monoxide (CO)	42*
Nitrogen Dioxide (NO_2)	1
Ozone (O_3)	98*
Lead (Pb)	12

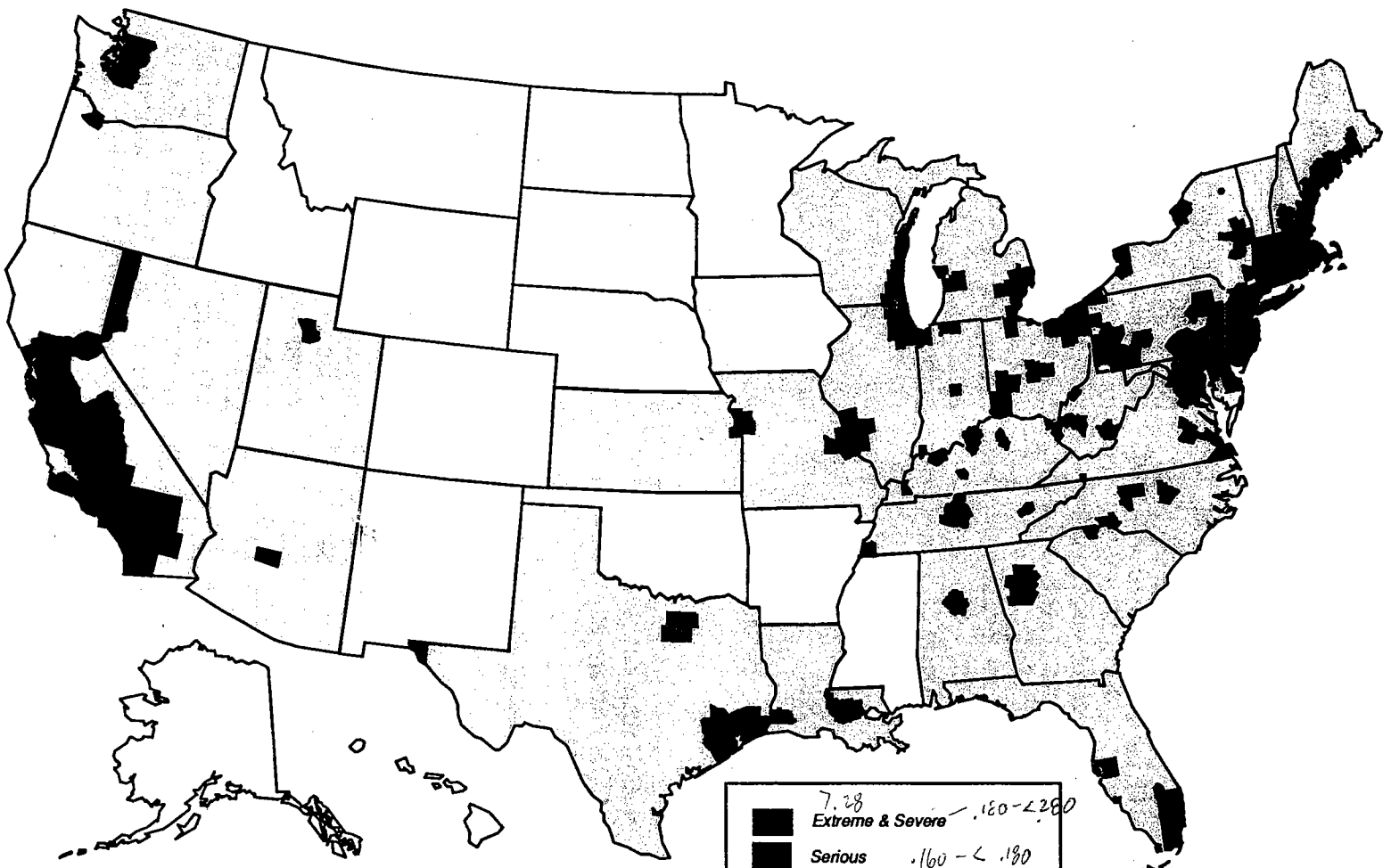
* Unclassified areas and transitional areas are not included in the totals.

4.1 Nonattainment Areas

This section presents maps indicating the nonattainment areas for each of the six NAAQS pollutants, except nitrogen dioxide. Because Los Angeles, CA is the only area currently not meeting the NO_2 standard, a map is not presented for this pollutant. The nonattainment designation is the result of a formal process but, for the purposes of this section, may be viewed as simply indicating areas that do not meet a specific air quality standard. The Clean Air Act Amendments (CAAA) of 1990 further classify ozone and carbon monoxide nonattainment areas based upon the magnitude of the problem. Depending on their particular nonattainment classification, the area must adopt, at a minimum, certain air pollution reduction measures. The classification of an area also determines when the area must reach attainment. The technical details underlying these classifications are discussed in Part 81 of the Code of Federal Regulations (Federal Register, November 6, 1991).[2] Table 4-1 displays the number of nonattainment areas for each pollutant.

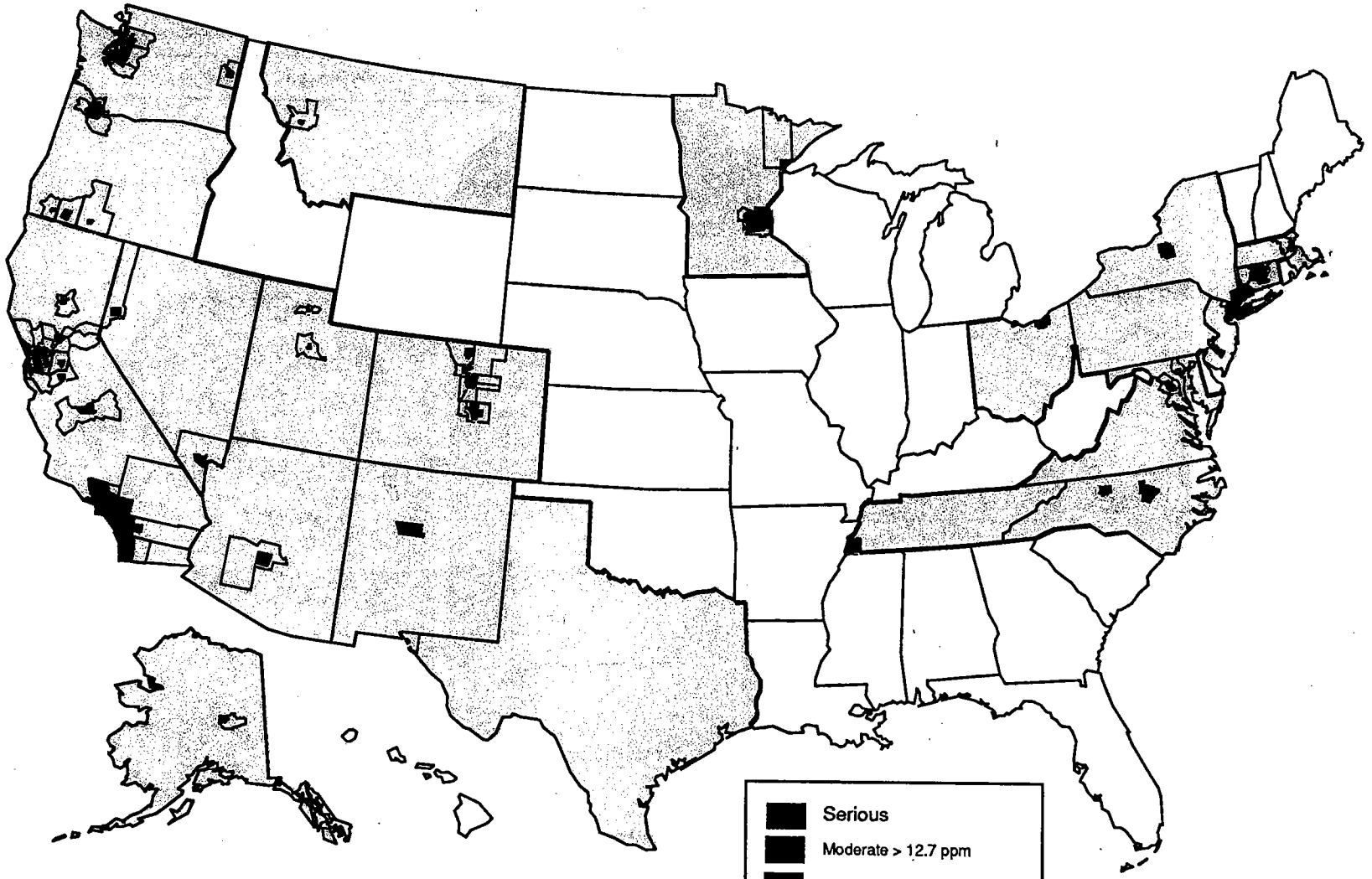
Figures 4-1 and 4-2 display the nonattainment areas for ozone and carbon monoxide, respectively. These maps also indicate the CAAA classifications which are based upon the design value, a concentration indicating the magnitude of the problem. To facilitate the identification of sub-county CO nonattainment areas, the county boundaries of these areas are highlighted in light-blue. States containing nonattainment areas are shown in yellow. Unclassified areas and transitional ozone areas are not displayed on the O_3 and CO maps. Figures 4-3 through 4-5 show the nonattainment areas for PM-10, SO_2 and Pb, respectively. States containing nonattainment areas are highlighted with solid color shading.

Areas Designated Nonattainment for Ozone

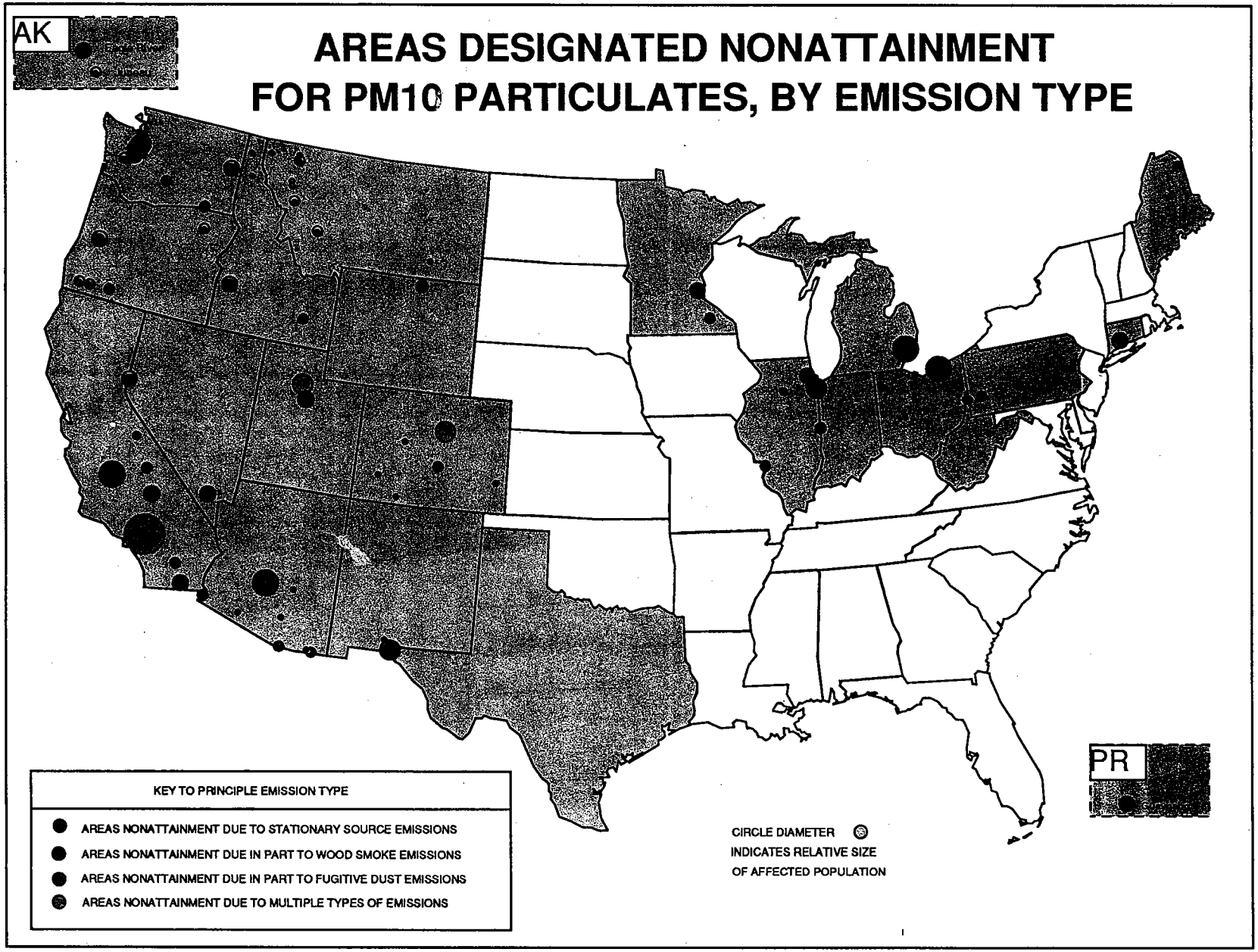


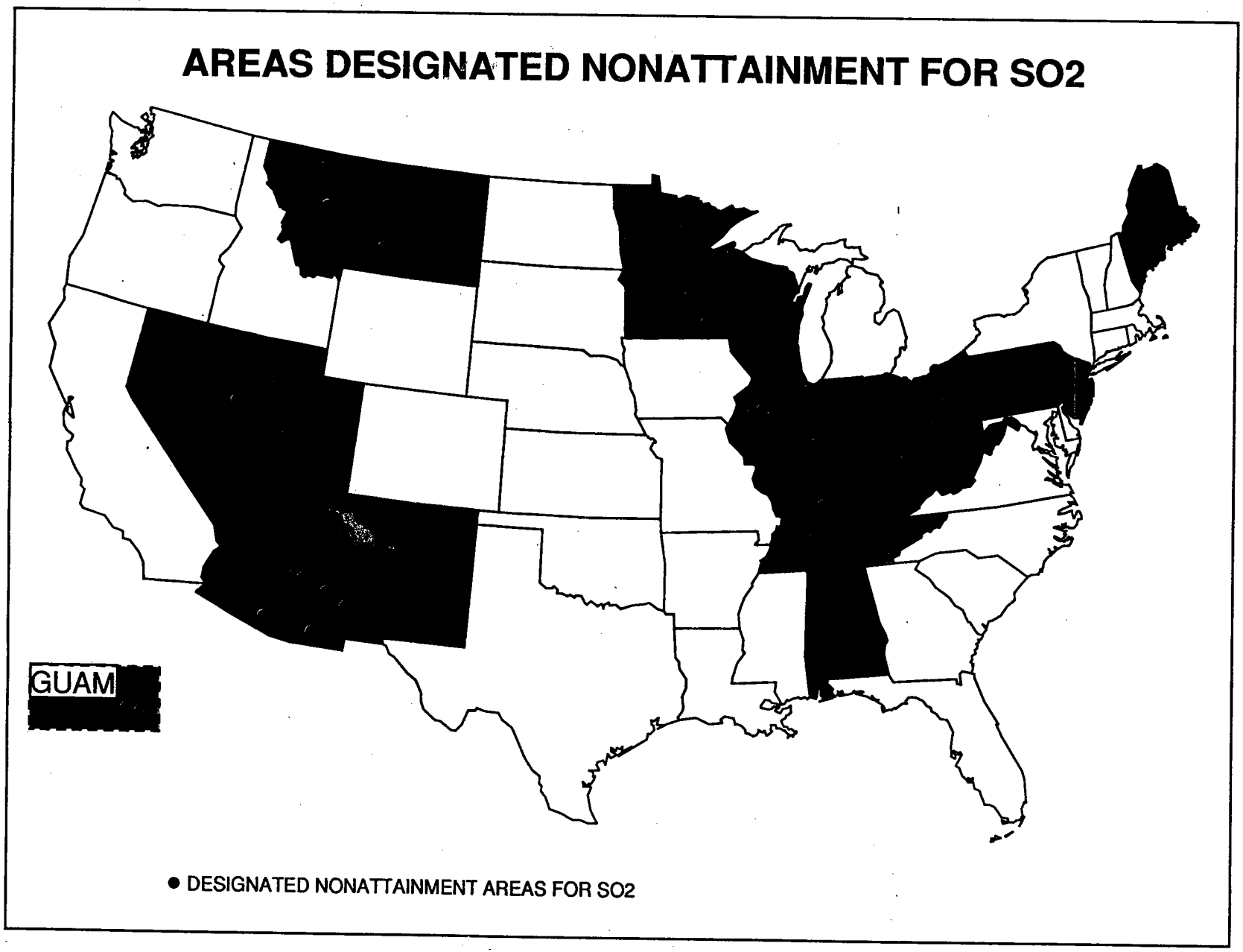
Note: Unclassified and transitional areas are not shown.

Areas Designated Nonattainment for Carbon Monoxide



Note: Unclassified areas are not shown.


AK
AREAS DESIGNATED NONATTAINMENT
FOR PM10 PARTICULATES, BY EMISSION TYPE
PR
KEY TO PRINCIPLE EMISSION TYPE
AREAS NONATTAINMENT DUE TO STATIONARY SOURCE EMISSIONS
AREAS NONATTAINMENT DUE IN PART TO WOOD SMOKE EMISSIONS
AREAS NONATTAINMENT DUE IN PART TO FUGITIVE DUST EMISSIONS
AREAS NONATTAINMENT DUE TO MULTIPLE TYPES OF EMISSIONS
CIRCLE DIAMETER
INDICATES RELATIVE SIZE
OF AFFECTED POPULATION


AREAS DESIGNATED NONATTAINMENT FOR SO2
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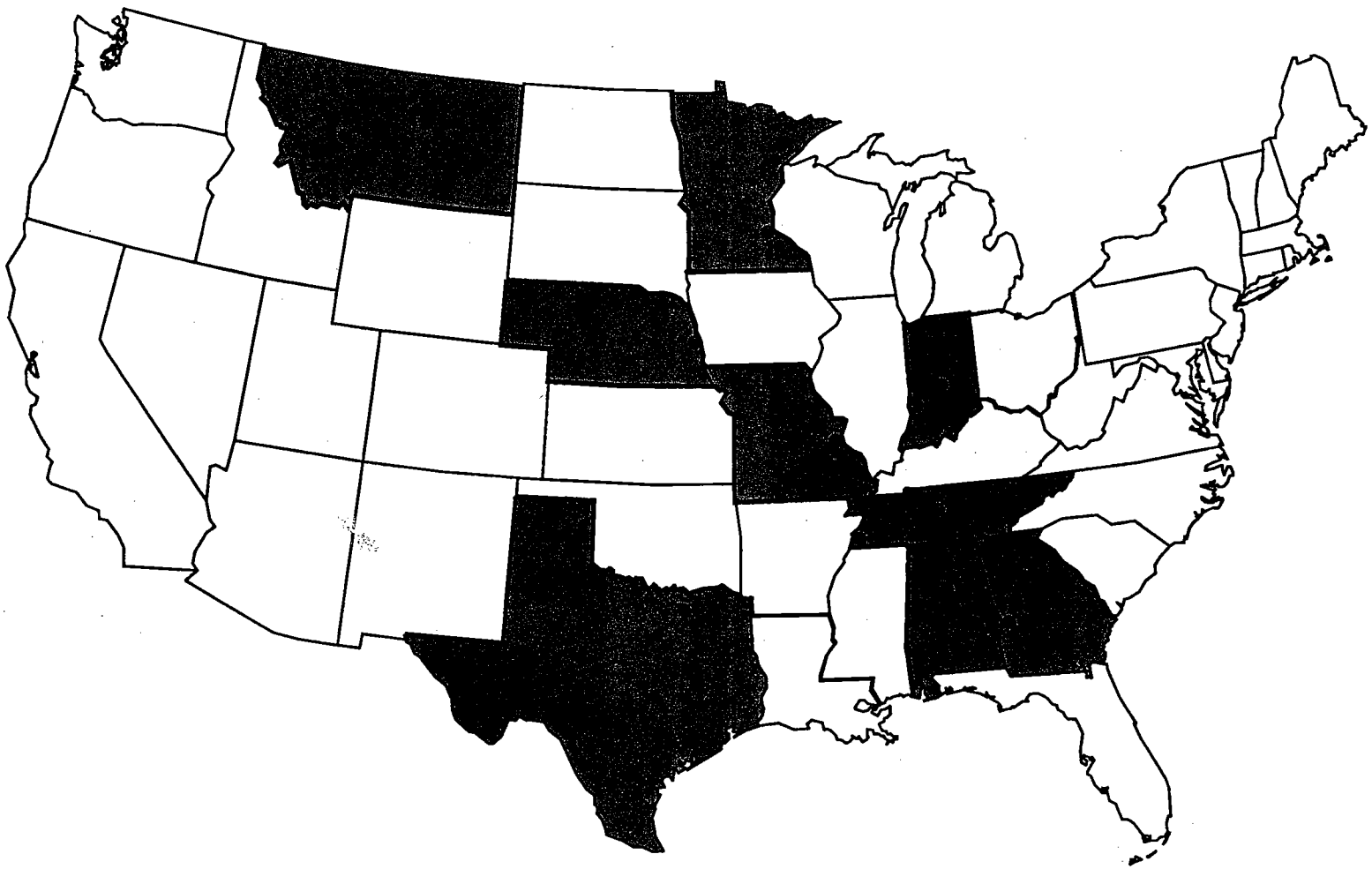
● DESIGNATED NONATTAINMENT AREAS FOR SO2

AREAS DESIGNATED NONATTAINMENT FOR LEAD

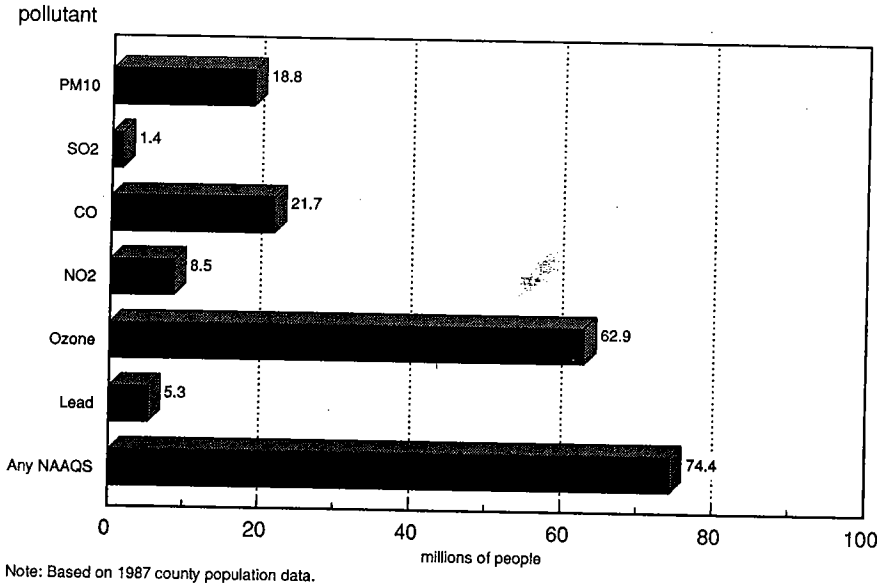


● INITIAL DESIGNATED NONATTAINMENT AREAS FOR LEAD

4.2 Population Estimates For Counties Not Meeting NAAQS, 1990

Figure 4-6 provides an estimate of the number of people living in counties in which the levels of the pollutant-specific primary health NAAQS were not met by measured air quality in 1990. These estimates use a single-year interpretation of the NAAQS to indicate the current extent of the problem for each pollutant. Table 2-1 lists the selected air quality statistics and their associated NAAQS. Figure 4-6 clearly demonstrates that O_3 was the most pervasive air pollution problem in 1990 for the United States with an estimated 62.9 million people living in counties which did not meet the O_3 standard. This estimate is slightly lower than last year's 1989 estimate of 66.7 million people. However, the population estimates for the past 2 years are substantially lower than the 112 million people living in areas which did not meet the ozone NAAQS in 1988. This large decrease is likely due in part to meteorological conditions in 1988 being more conducive to ozone formation than recent years (recall the hot, dry summer in the eastern U.S.), and to new and ongoing emission control programs. Between 1988 and 1989, implementation of gasoline volatility regulations lowered the average Reid Vapor Pressure (RVP) of regular unleaded gasoline from 10.0 to 8.9 pounds per square inch (psi). RVP was reduced an additional 3 percent between 1989 and 1990. Carbon monoxide follows with 21.7 million people; PM-10 with 18.8 million people; NO_2 with 8.5 million people; Pb with 5.3 million people and SO_2 with 1.4 million people. A total of 74 million persons resided in counties not meeting at least one air quality standard during 1990 (out of a total 1987 population of 243 million). Future reports will incorporate the 1990 Census population estimates.

These population estimates are intended to provide a relative measure of the extent of the problem for each pollutant. The limitations of this indicator should be recognized. An individual living in a county that violates an air quality standard may not actually be exposed to unhealthy air. For example, if CO violations were confined to a traffic-congested center city location during evening rush hours in the winter, it is possible that an individual may never be in that area, or may be there only at other times of the day or during other seasons. However, it is worth noting that ozone, which appears to be the most pervasive pollution problem by this measure, is also the pollutant most likely to have fairly uniform concentrations throughout an area.



Note: Based on 1987 county population data.

Figure 4-6. Number of persons living in counties with air quality levels above the primary national ambient air quality standards in 1990 (based on 1987 population data).

Any population estimates depend upon the assumptions and methodology used. In some cases there can be a wide swing in the estimate. For example, while there are an estimated 63 million people living in counties that had 1990 ozone data not meeting the ozone NAAQS, there are an estimated 140 million people living in ozone nonattainment areas. Although these numbers are properly qualified, with such a large difference, it is important to highlight some of the factors involved in these estimates.

The estimate of 63 million people only considers data from the single year, 1990 and only considers counties with ozone monitoring data. In contrast, ozone nonattainment areas are typically based upon three years of data to ensure a broader representation of possible meteorological conditions. This use of multiple years of data, rather than a single year, is intended to ensure that the attainment decision is not simply the result of data from a single year and should provide more assurance that the NAAQS is met over all years, not simply in favorable years.

Another difference is that the estimate of 63 million people living in counties with air quality levels not meeting the ozone NAAQS only considers counties that had ozone monitoring data for 1990. As shown in Table 2-2, there were only 812 ozone monitors reporting in 1990. These monitors were located in 467 counties, which clearly falls far short of the 3186 counties in the U.S. This shortfall is not as bad as it may initially appear because it is often possible to take advantage of other air quality considerations in interpreting the monitoring data. This, in fact, is why other factors are considered in determining nonattainment areas. Ozone tends to be an area-wide problem with fairly similar levels occurring across broad regions. Because ozone is not simply a localized hot-spot problem, effective ozone control strategies have to incorporate a broad view of the problem. Nonattainment boundaries may consider other air quality related information, such as emission inventories and modeling, and may extend beyond those counties with monitoring data to more fully characterize the ozone problem and to facilitate the development of an adequate control strategy.

Since the early 1970's, there has been a growing awareness that ozone and ozone precursors are transported beyond the political jurisdiction of source areas and affect air quality levels at considerable distances downwind. To address this aspect of the problem, the 1990 Clean Air Act Amendments establishes a transport commission for the Northeast, and allows the establishment of commissions in other parts of the country. Generally speaking, an entire transport region, including its rural areas, is subject to the same requirements as moderate areas.

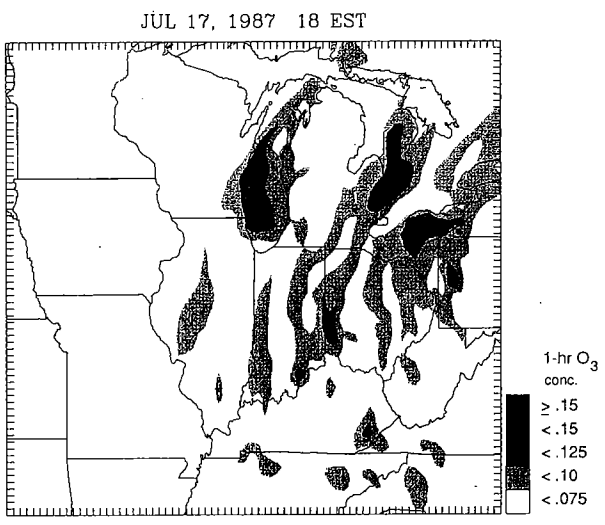


Figure 4-7. Midwest region on July 17, 1987.

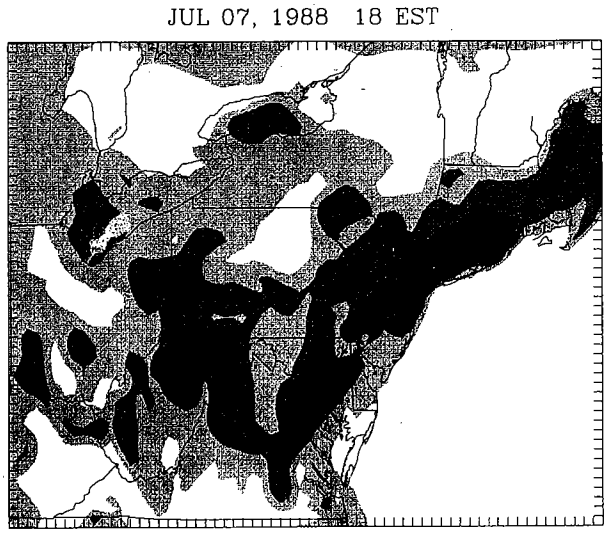


Figure 4-8. Northeast region on July 7, 1988.

The transport of ozone concentrations generated from urban manmade emissions of precursors in numerous areas to locations further downwind can result in rather widespread areas of elevated levels of ozone across regional spatial scales. Visualizing the regional nature of ozone transport is difficult using monitoring data because ambient measurements are available from only a discrete number of individual sites which are generally concentrated in or near major cities. In this sense, modeling data, which produce three-dimensional predictions of air quality, can provide added insight into transport patterns. Several examples of urban ozone plumes and their interaction on a regional scale are shown from predictions of the Regional Oxidant Model (ROM) for the Midwest and Northeast U.S. in Figures 4-7 through 4-10. Each figure displays ROM ozone predictions for a single hour extracted from simulations which encompass multi-day episodes. On July 17, 1987 (Figure 4-7), urban ozone plumes extend from the major Midwest cities downwind with the southerly wind flow on this day. Note the high ozone predicted along the western shore of Lake Michigan and offshore over the Lake resulting from urban areas along the western shore. Also, ozone plumes from cities along the Ohio River extend northward as far as Detroit.

In the Northeast, predictions for July 7, 1988 (Figure 4-8) reveal a continuous "river" of moderately high ozone extending from eastern Ohio southeastward to Richmond, VA then northeastward along the Northeast Corridor from Washington, DC to coastal Maine. Ozone plumes with concentrations exceeding the level of the NAAQS are embedded within this area over and downwind of major ozone-precursor emissions areas. In fact, a continuous area with ozone levels at or above .12 ppm are predicted from southeastern Pennsylvania into Rhode Island. Finally, comparing ozone patterns for 1400 EST and 2300 EST on July 8, 1988, (Figures 4-9 and 4-10) shows the transport of ozone exceeding .15 ppm to the Boston area from sources further to the Southwest during this time period.

These isopleth maps illustrate the spatial patterns associated with ozone. They also serve to indicate how a broader view based upon a variety of air quality considerations could differ from an interpretation based only upon a single year of monitoring data from a limited number of sites. The nonattainment area approach reflects a broader range of meteorological conditions and incorporates control strategy considerations. The single year population estimate, using only monitoring data, provides a convenient snapshot that emphasizes the most recent status.

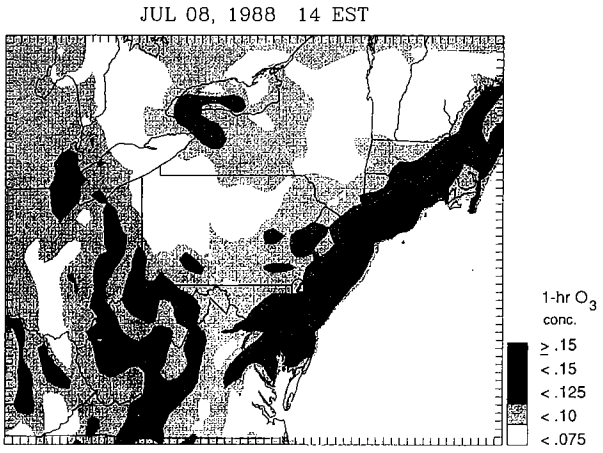


Figure 4-9. Northeast region at 1400 EST on July 8, 1988.

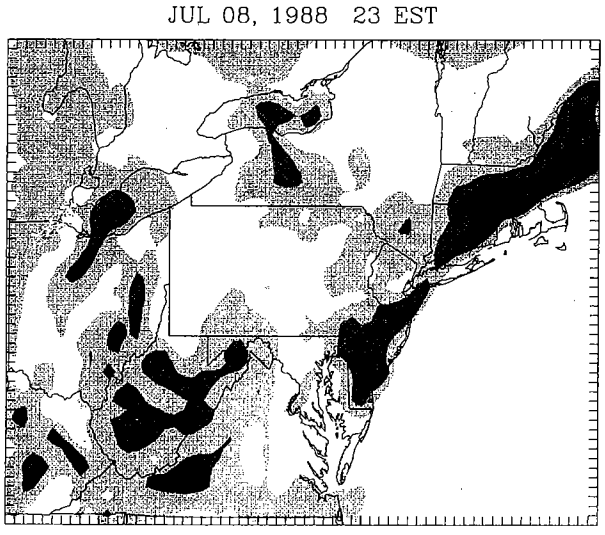


Figure 4-10. Northeast region at 2300 EST on July 8, 1988.

4.3 Air Quality Levels in Metropolitan Statistical Areas

This section provides information on 1990 air quality levels in each Metropolitan Statistical Area (MSA) in the United States for general air pollution audiences. For those large MSAs with populations greater than 500,000, the 1990 annual air quality statistics are also displayed geographically on three-dimensional maps.

The general concept of a metropolitan area is one of a large population center, with adjacent communities which have a high degree of economic and social integration with the urban center. Metropolitan Statistical Areas contain a central county(ies), and any adjacent counties with at least 50 percent of their population in the urbanized area.[1] Although MSAs compose only 16 percent of the land area in the U.S., they account for 78 percent of the total population of 243 million. Table 4-2 displays the population distribution of the 341 MSAs, based on 1987 population estimates.[1] The New York, NY MSA is the nation's largest metropolitan area with a 1987 population in excess of 8 million. The smallest MSA is Enid, OK with a population of 60,000.

4.3.1 Metropolitan Statistical Area Air Quality Maps, 1990

Figures 4-11 through 4-18 introduce air quality maps of the United States that show at a glance how air quality varies among the largest MSAs within the contiguous United States. To enable the reader to distinguish individual urban areas, only the 90 MSAs within the continental U.S. having populations greater than 500,000 are shown. Two large MSAs, Honolulu, HI and San Juan, PR are not shown. However, neither area has exceeded any of the NAAQS during 1990. In each map, a spike is plotted at the city location on the map surface. This represents the highest pollutant concentration recorded in 1990, corresponding to the appropriate air quality standard. Each spike is projected onto a back-drop for comparison with the level of the standard. The backdrop also provides an east-west profile of concentration variability throughout the country.

TABLE 4-2. Population Distribution of Metropolitan Statistical Areas Based on 1987 Population Estimates

POPULATION RANGE	NUMBER OF MSA'S	POPULATION
$\leq$ 100,000	28	2,367,600
100,000 < population $\leq$ 250,000	148	23,513,000
250,000 < population $\leq$ 500,000	73	25,218,000
500,000 < population $\leq$ 1,000,000	48	34,367,000
1,000,000 < population $\leq$ 2,000,000	26	38,685,000
population > 2,000,000	18	65,747,000
MSA TOTAL	341	189,897,600

4.3.2 Metropolitan Statistical Area Air Quality Summary, 1990

Table 4-3 presents a summary of 1990 air quality for each Metropolitan Statistical Area (MSA) in the United States. The air quality levels reported for each metropolitan area are the highest levels measured from all available sites within the MSA. The MSAs are listed alphabetically, with the 1987 population estimate and air quality statistics for each pollutant. Concentrations above the level of the respective NAAQS are shown in **bold** type.

In the case of O_3, the problem is pervasive, and the high values associated with the pollutant can reflect a large part of the MSA. However in many cases, peak ozone concentrations occur downwind of major urban areas, e.g., peak ozone levels attributed to the Chicago metropolitan area are recorded in and near Kenosha, Wisconsin. In contrast, high CO values generally are highly localized and reflect areas with heavy traffic. The scale of measurement for the pollutants - PM-10, SO_2 and NO_2 - falls somewhere in between. Finally, while Pb measurements generally reflect Pb concentrations near roadways in the MSA, if a monitor is located near a point source of lead emissions it can produce readings substantially higher. Such is the case in several MSAs. Pb monitors located near a point source are footnoted accordingly in Table 4-3.

The pollutant-specific statistics reported in this section are for a single year of data. For example, if an MSA has three ozone monitors in 1990 with second highest daily hourly maxima of 0.15 ppm, 0.14 ppm and 0.12 ppm, the highest of these, 0.15 ppm, would be reported for that MSA. The associated primary NAAQS concentrations for each pollutant are summarized in Table 2-1.

The same annual data completeness criteria used in the air quality trends data base for continuous data was used here for the calculation of annual means. (i.e., 50 percent of the required samples for SO_2 and NO_2). If some data have been collected at one or more sites, but none of these sites meet the annual data completeness criteria, then the reader will be advised that there are insufficient data to calculate the annual mean. With respect to the summary statistics on air quality levels with averaging times less than or equal to 24-hours, all sites are included, even if they do not meet the annual data completeness requirement.

For PM-10 and Pb, the arithmetic mean statistics are based on 24-hour measurements, which are typically obtained from a systematic sampling schedule. In contrast to the trends analyses in Section 3 which used a more relaxed indicator, only maximum quarterly average Pb concentrations and weighted PM-10 annual means meeting the AIRS validity criteria are displayed in Table 4-3.

This summary provides the reader with information on how air quality varied among the nation's metropolitan areas in 1990. The highest air quality levels measured in each MSA are summarized for each pollutant monitored in 1990. Individual MSAs are listed to provide more extensive spatial coverage for large metropolitan complexes.

The reader is cautioned that this summary is not adequate in itself to numerically rank MSAs according to their air quality. To rank properly the air pollution severity among different MSAs, data on population characteristics, daily population mobility, transportation patterns, industrial composition, emission inventories, meteorological factors and, most important, the spatial representativeness of the monitoring sites would also be needed.

4.4 REFERENCES

1. Statistical Abstract of the United States, 1989, U. S. Department of Commerce, U. S. Bureau of the Census, Appendix II.

2. 40CFR, PART 81 (Federal Register, November 6, 1991).

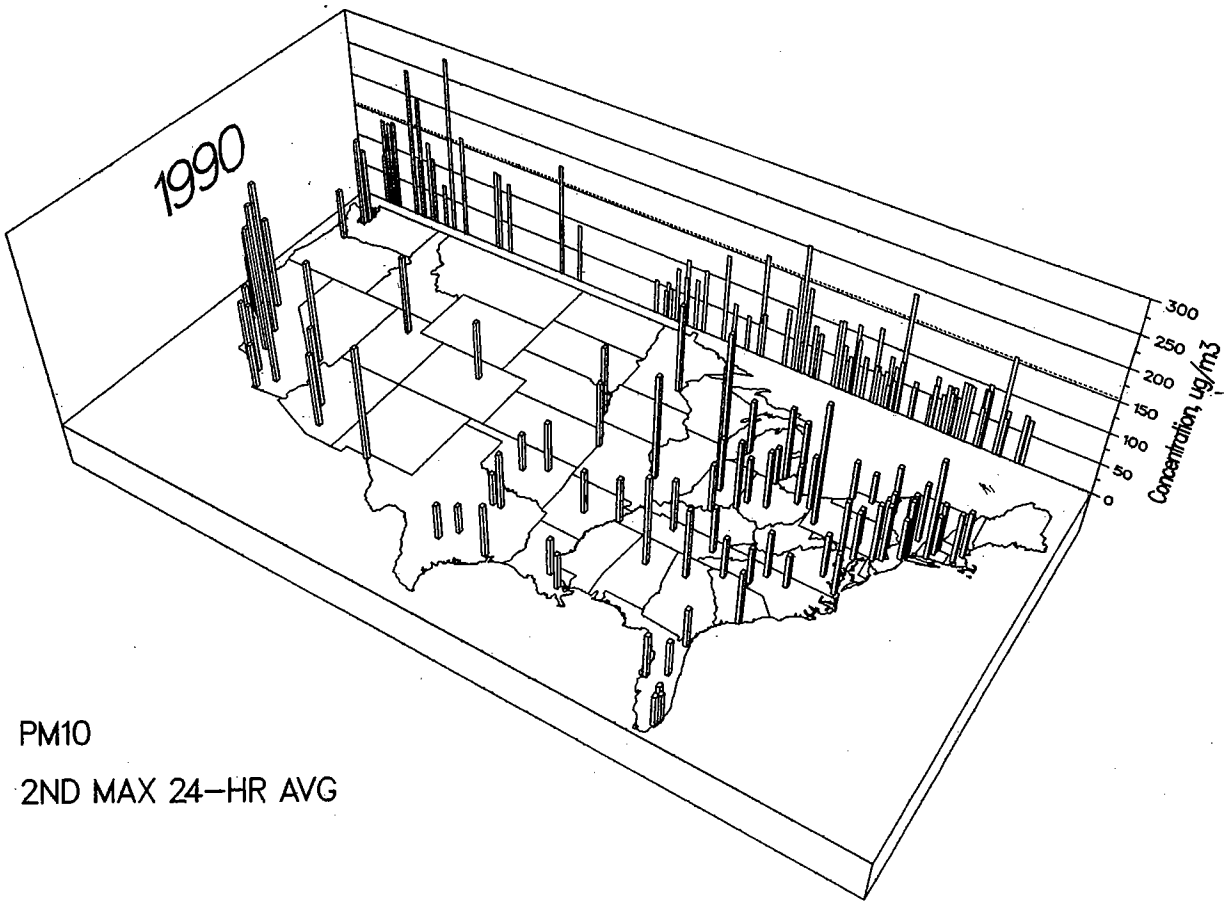


Figure 4-11. United States map of the highest second maximum 24-hour average PM-10 concentration by MSA, 1990.

The map for PM-10 shows the 1990 highest second maximum 24-hour average PM-10 concentration in metropolitan areas greater than 500,000 population. Concentrations above the level of the 24-hour PM-10 standard of 150 $\mu g/m^3$ are found in 9 of these metropolitan areas.

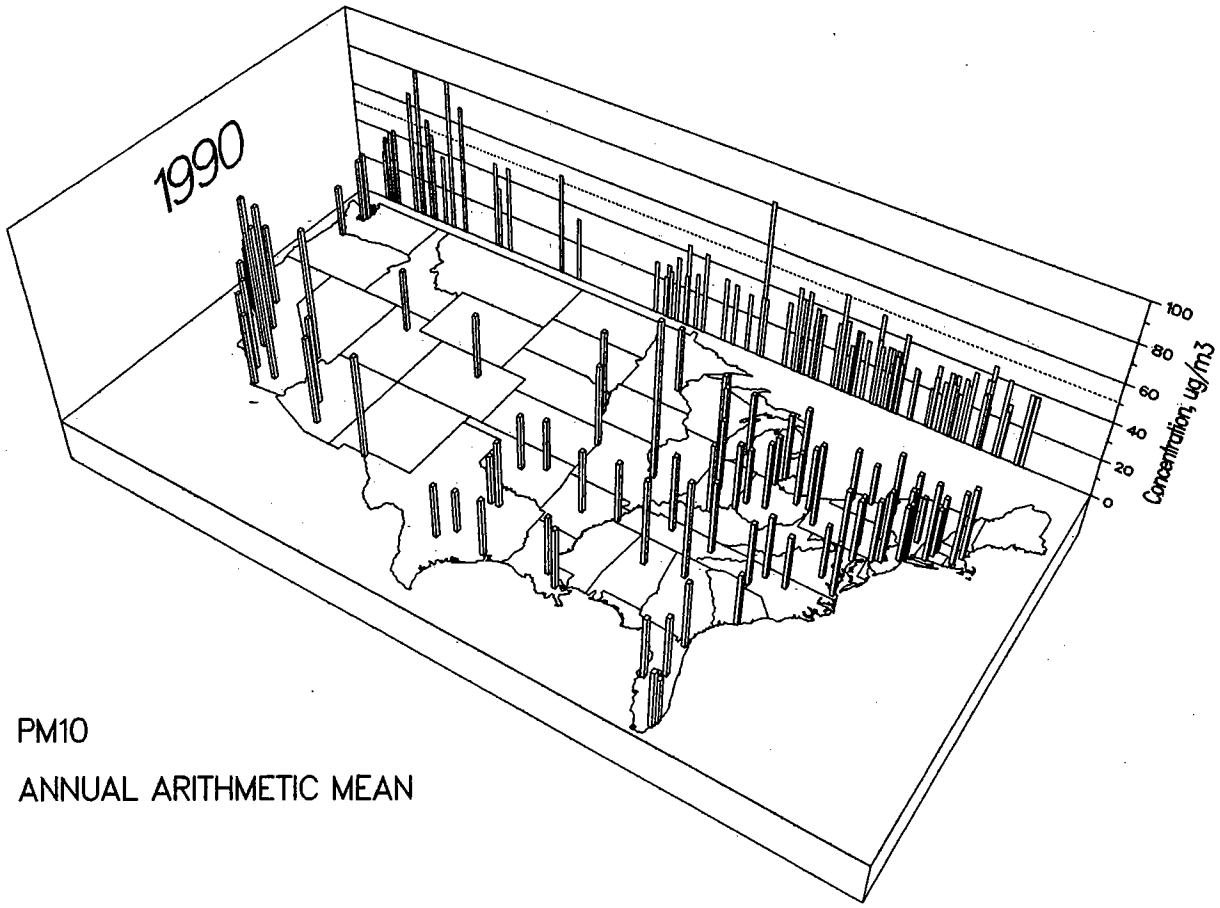


Figure 4-12. United States map of the highest annual arithmetic mean PM-10 concentration by MSA, 1990.

The map for PM-10 shows the 1990 maximum annual arithmetic means in metropolitan areas greater than 500,000 population. Concentrations above the level of the annual mean PM-10 standard of 50 $\mu g/m^3$ are found in 8 of these metropolitan areas.

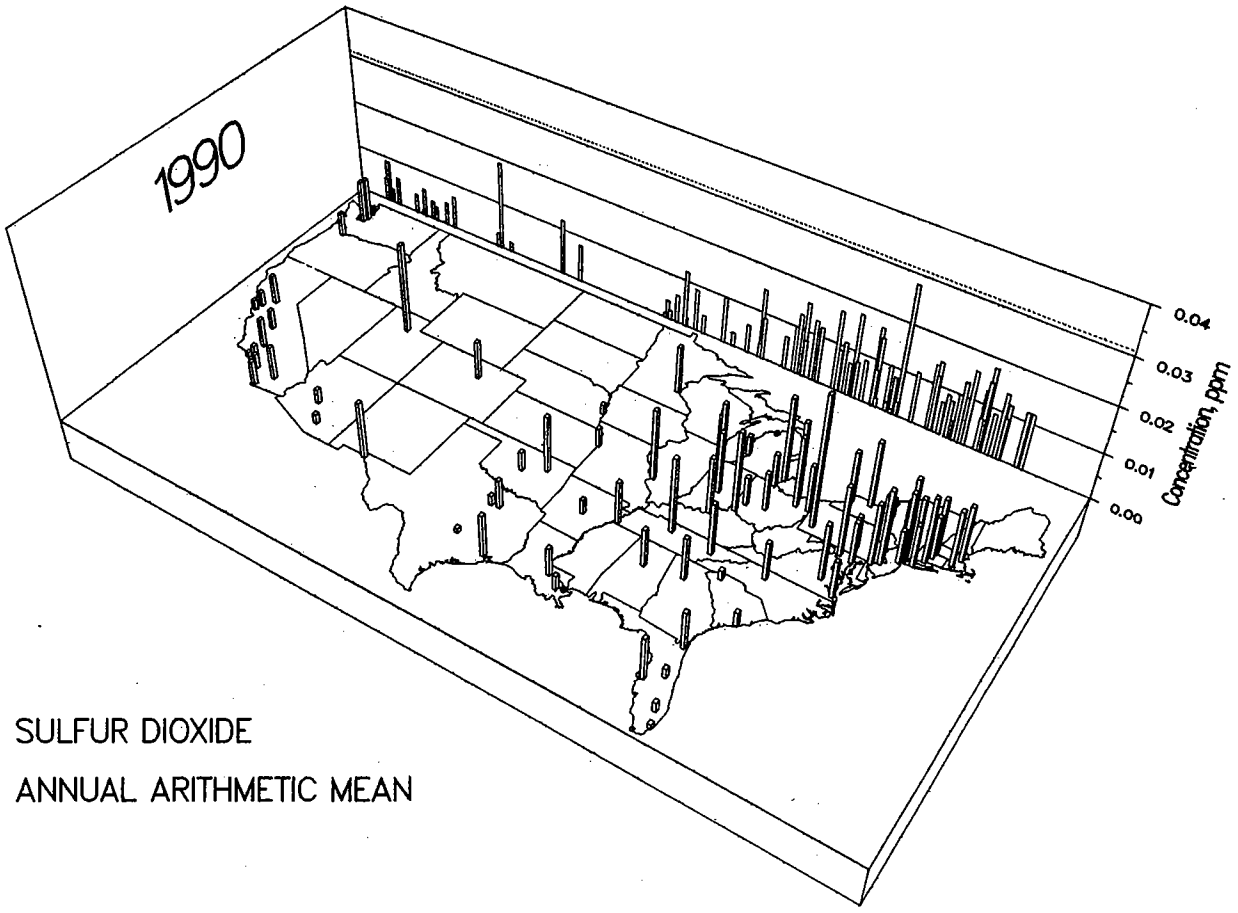


Figure 4-13. United States map of the highest annual arithmetic mean sulfur dioxide concentration by MSA, 1990.

The map for sulfur dioxide shows maximum annual mean concentrations in 1990. Among these large metropolitan areas, the higher concentrations are found in the heavily populated Midwest and Northeast and near point sources in the west. All these large urban areas have ambient air quality concentrations lower than the current annual standard of 80 $\mu g/m^3$ (0.03 ppm). Because this map only represents areas with population greater than one half million, it does not reflect air quality in the vicinity of smelters or large power plants in rural areas.

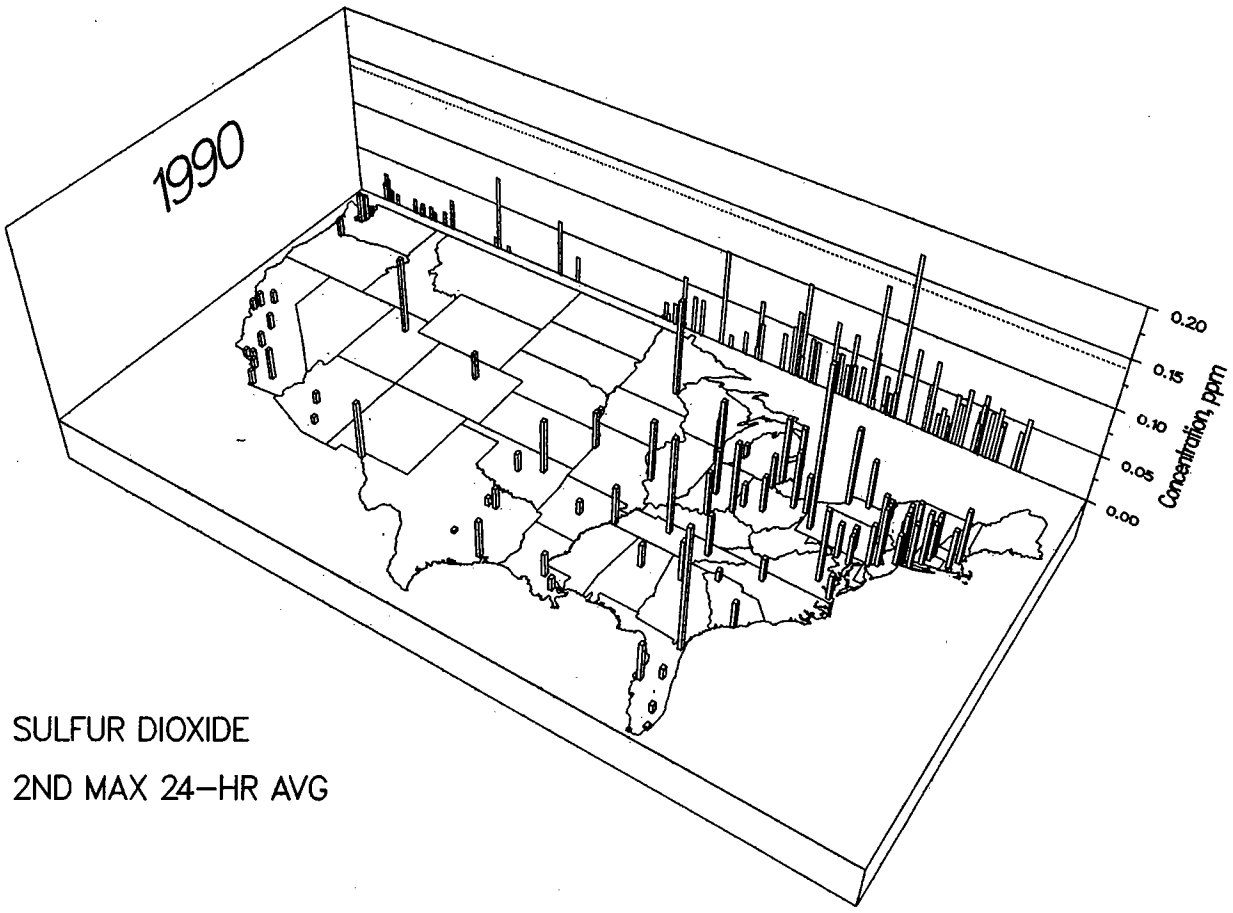


Figure 4-14. United States map of the highest second maximum 24-hour average sulfur dioxide concentration by MSA, 1990.

The map for sulfur dioxide shows the highest second highest 24-hour average sulfur dioxide concentration by MSA in 1990. Pittsburgh, PA is the only large urban area which had ambient concentrations above the 24-hour NAAQS of 365 $\mu g/m^3$ (0.14 ppm).

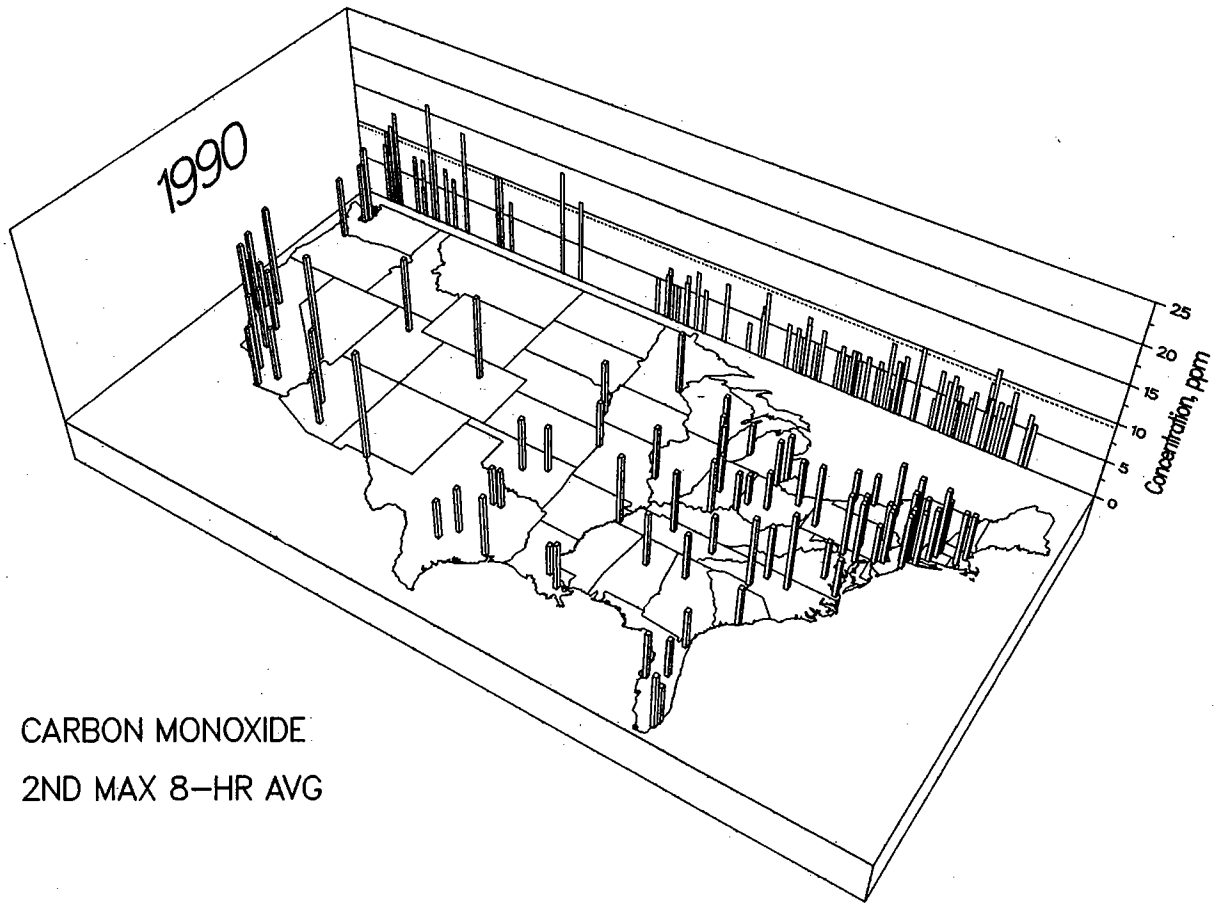


Figure 4-15. United States map of the highest second maximum nonoverlapping 8-hour average carbon monoxide concentration by MSA, 1990.

The map for carbon monoxide shows the highest second highest 8-hour value recorded in 1990. Twelve of these urban areas have air quality exceeding the 9 ppm level of the standard. The highest concentration recorded in 1990 is found in Los Angeles, CA.

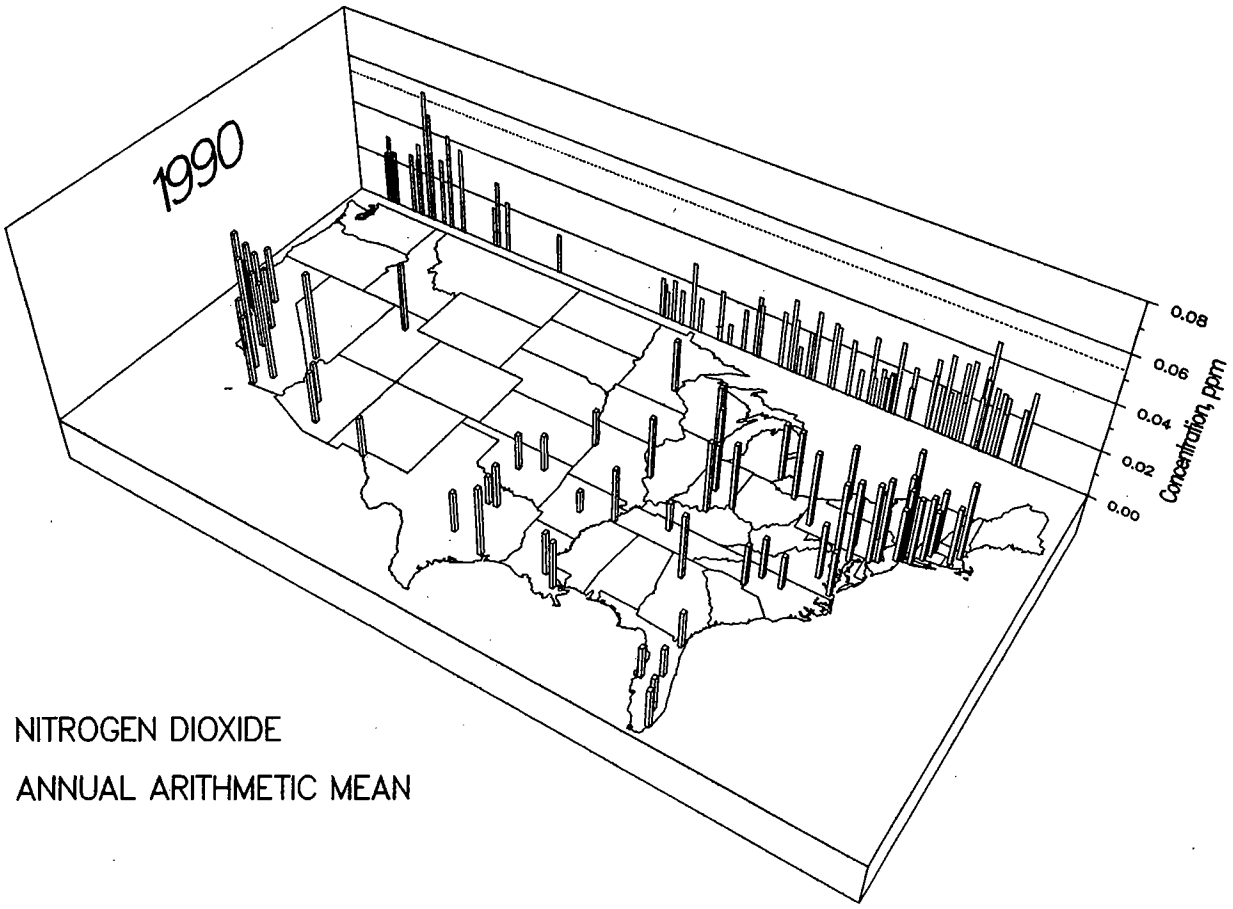


Figure 4-16. United States map of the highest annual arithmetic mean nitrogen dioxide concentration by MSA, 1990.

The map for nitrogen dioxide displays the maximum annual mean measured in the nation's largest metropolitan areas during 1990. Los Angeles, California, with an annual NO_2 mean of 0.056 ppm is the only area in the country exceeding the NO_2 air quality standard of 0.053 ppm.

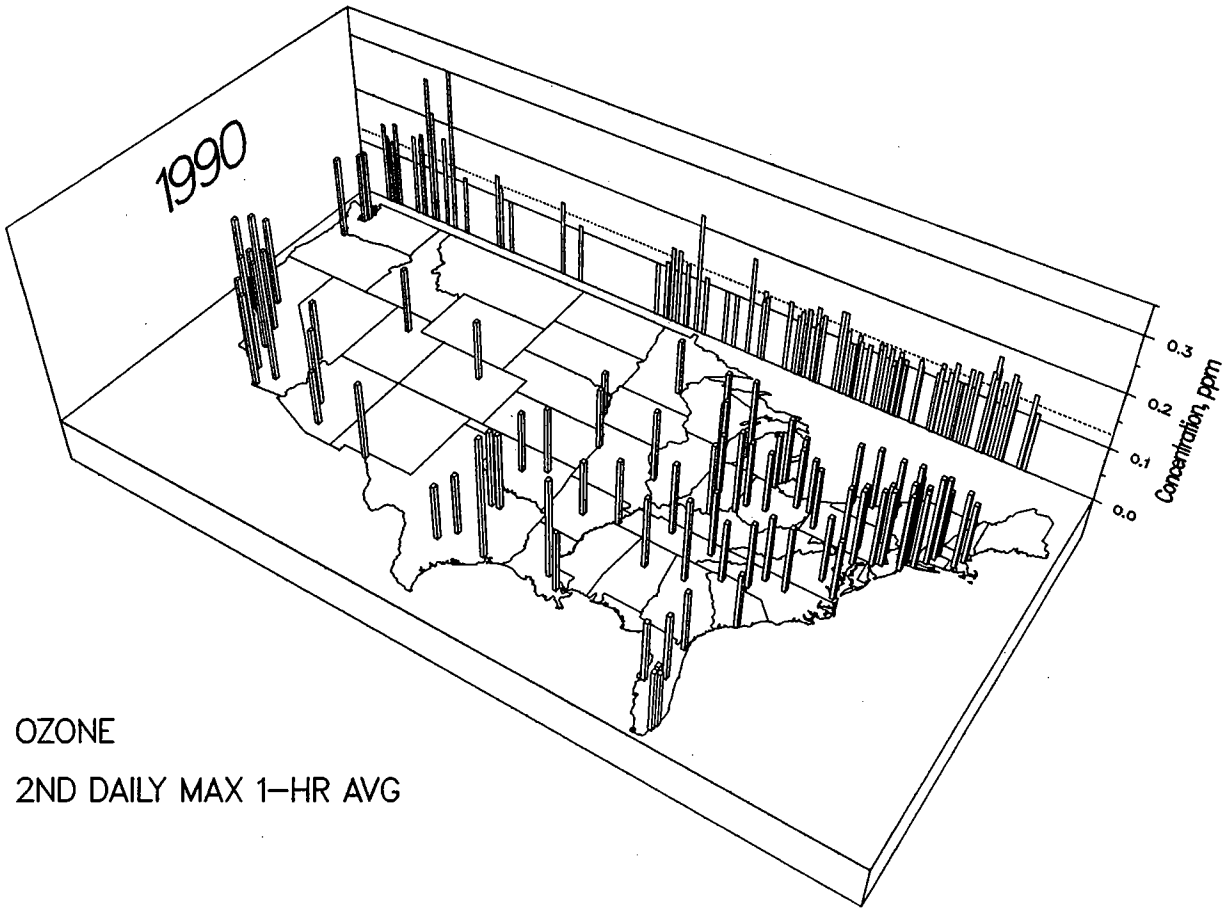


Figure 4-17. United States map of the highest second daily maximum 1-hour average ozone concentration by MSA, 1990.

The ozone map shows the second highest daily maximum 1-hour concentration in the 90 largest metropolitan areas in the Continental U.S. As shown, 39 of these areas did not meet the 0.12 ppm standard in 1990. The highest concentrations are observed in Southern California, but high levels also persist in the Texas Gulf Coast, Northeast Corridor and other heavily populated regions.

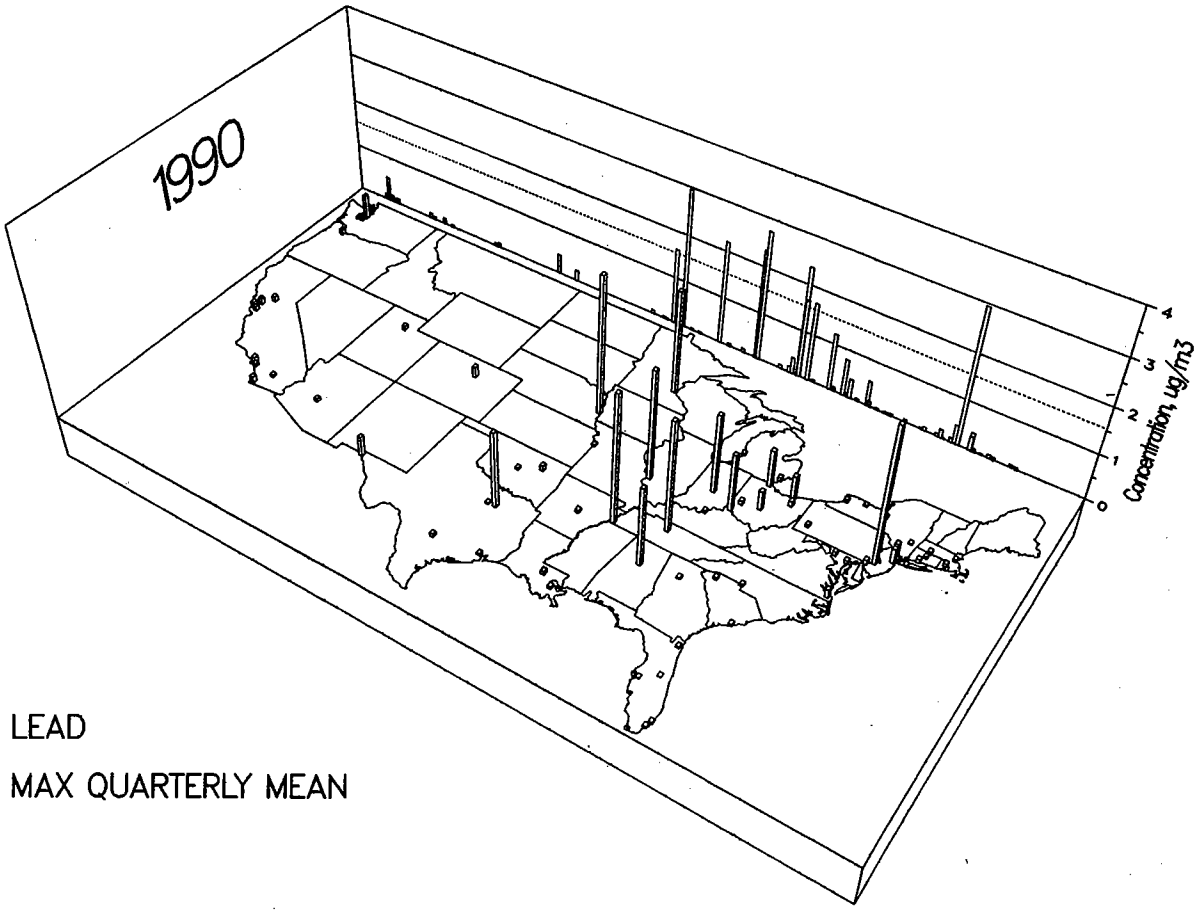


Figure 4-18. United States map of the highest maximum quarterly average lead concentration by MSA, 1990.

The map for Pb displays maximum quarterly average concentrations in the nation's largest metropolitan areas. Exceedances of the Pb NAAQS are found in nine areas in the vicinity of nonferrous smelters or other point sources of lead. Because of the switch to unleaded gasoline, areas primarily affected by automotive lead emissions show levels below the current standard of 1.5 $\mu g/m^3$.

TABLE 4-3. 1990 METROPOLITAN STATISTICAL AREA AIR QUALITY FACTBOOK
PEAK STATISTICS FOR SELECTED POLLUTANTS BY MSA

METROPOLITAN STATISTICAL AREA	1990 POPULATION	PM10 2ND MAX (UGM)	PM10 WTD AM (UGM)	SO2 AM (PPM)	SO2 24-HR (PPM)	CO 8-HR (PPM)	NO2 AM (PPM)	OZONE 2ND MAX (PPM)	PB QMAX (UGM)
ABILENE, TX	123,000	ND	ND	ND	ND	ND	ND	ND	ND
AGUADILLA, PR	156,000	ND	ND	ND	ND	ND	ND	ND	ND
AKRON, OH	647,000	62	28	0.015	0.061	6	ND	0.11	0.11
ALBANY, GA	117,000	ND	ND	ND	ND	ND	ND	ND	ND
ALBANY-SCHENECTADY-TROY, NY	846,000	92	24	0.01	0.047	6	ND	0.11	0.03
ALBUQUERQUE, NM	486,000	127	40	ND	ND	11	0.018	0.10	ND
ALEXANDRIA, LA	140,000	ND	ND	ND	ND	ND	ND	ND	ND
ALLENTOWN-BETHLEHEM, PA-NJ	666,000	91	30	0.01	0.044	6	0.017	0.11	0.4
ALTOONA, PA	132,000	53	21	0.011	0.062	ND	ND	0.10	ND
AMARILLO, TX	197,000	26	IN	ND	ND	ND	ND	ND	ND
ANAHEIM-SANTA ANA, CA	2,219,000	108	48	0.003	0.01	10	0.047	0.21	0.06
ANCHORAGE, AK	223,000	137	37	ND	ND	12	ND	ND	ND
ANDERSON, IN	133,000	80	26	ND	ND	ND	ND	ND	ND
ANDERSON, SC	141,000	ND	ND	ND	ND	ND	ND	ND	ND
ANN ARBOR, MI	268,000	ND	ND	ND	ND	ND	ND	0.09	0.02
ANNISTON, AL	122,000	64	28	ND	ND	ND	ND	ND	ND
APPLETON-OSHKOSH-NEENAH, WI	309,000	ND	ND	ND	ND	ND	ND	0.08	ND
ARECIBO, PR	170,000	ND	ND	ND	ND	ND	ND	ND	ND
ASHEVILLE, NC	171,000	49	25	ND	ND	ND	ND	0.09	ND
ATHENS, GA	142,000	ND	ND	ND	ND	ND	ND	ND	ND
ATLANTA, GA	2,657,000	110	51 #	0.009	0.043	6	0.027	0.15	0.03
ATLANTIC CITY, NJ	303,000	59	IN	0.004	0.012	ND	ND	0.16	0.02
AUGUSTA, GA-SC	392,000	53	22	ND	ND	ND	ND	0.11	0.02
AURORA-ELGIN, IL	352,000	ND	ND	ND	ND	ND	ND	0.09	ND
AUSTIN, TX	738,000	44	22	0.001	0.003	6	0.017	0.11	ND
BAKERSFIELD, CA	505,000	197	79	0.006	0.014	8	0.032	0.16	ND
BALTIMORE, MD	2,303,000	77	33	0.009	0.032	8	0.034	0.14	0.06
BANGOR, ME	84,000	37	21	ND	ND	ND	ND	ND	0.03
BATON ROUGE, LA	538,000	58	31	0.006	0.024	4	0.018	0.18	0.08
BATTLE CREEK, MI	138,000	69	IN	ND	ND	ND	ND	ND	ND
BEAUMONT-PORT ARTHUR, TX	371,000	48	IN	0.01	0.055	2	0.013	0.15	0.02
BEAVER COUNTY, PA	191,000	55	24	0.023	0.108	4	0.02	0.10	0.22
BELLINGHAM, WA	115,000	67	IN	0.007	0.028	5	ND	0.08	ND
BENTON HARBOR, MI	165,000	ND	ND	ND	ND	ND	ND	ND	ND
BERGEN-PASSAIC, NJ	1,294,000	94	45	0.01	0.042	8	0.031	0.13	0.04
BILLINGS, MT	118,000	53	24	0.017	0.095	6	ND	ND	ND
BILOXI-GULFPORT, MS	206,000	ND	ND	0.007	0.037	ND	ND	ND	ND
BINGHAMTON, NY	260,000	49	IN	ND	ND	ND	ND	ND	ND
BIRMINGHAM, AL	917,000	140	45	0.008	0.024	7	ND	0.13	1.68 *
BISMARK, ND	86,000	84	24	ND	ND	ND	ND	ND	ND

BLOOMINGTON, IN	104,000	ND	ND	ND	ND	ND	ND	ND	ND
BLOOMINGTON-NORMAL, IL	124,000	ND	ND	ND	ND	ND	ND	ND	ND
BOISE CITY, ID	196,000	124	35	ND	ND	ND	ND	ND	ND
BOSTON, MA	2,842,000	73	38	0.012	0.057	6	0.032	0.11	0.05
BOULDER-LONGMONT, CO	217,000	84	21	ND	ND	7	ND	0.10	ND
BRADENTON, FL	184,000	ND	ND	ND	ND	ND	ND	0.10	ND
BRAZORIA, TX	187,000	ND	ND	ND	ND	ND	ND	0.15	ND
BREMERTON, WA	174,000	ND	ND	ND	ND	ND	ND	ND	ND
BRIDGEPORT-MILFORD, CT	444,000	60	33	0.013	0.05	5	0.026	0.16	0.04
BRISTOL, CT	78,000	44	20	ND	ND	ND	ND	ND	ND
BROCKTON, MA	185,000	ND	ND	ND	ND	ND	ND	0.12	ND
BROWNSVILLE-HARLINGEN, TX	264,000	51	26	ND	ND	ND	ND	ND	ND
BRYAN-COLLEGE STATION, TX	118,000	ND	ND	ND	ND	ND	ND	ND	ND
BUFFALO, NY	958,000	61	27	0.011	0.081	4	0.023	0.11	0.06
BURLINGTON, NC	105,000	ND	ND	ND	ND	ND	ND	ND	ND
BURLINGTON, VT	127,000	66	25	0.008	0.021	5	0.018	ND	ND
CAGUAS, PR	275,000	ND	ND	ND	ND	ND	ND	ND	ND
CANTON, OH	397,000	72	32	0.011	0.037	3	ND	0.11	ND
CASPER, WY	67,000	ND	ND	ND	ND	ND	ND	ND	ND
CEDAR RAPIDS, IA	170,000	80	28	0.009	0.075	5	ND	0.07	ND
CHAMPAIGN-URBANA-RANTOUL, IL	173,000	66	28	0.004	0.03	ND	ND	0.09	ND
CHARLESTON, SC	502,000	83	27	0.003	0.027	5	IN	0.10	0.04
CHARLESTON, WV	261,000	72	36	0.015	0.073	4	0.02	0.12	0.07
CHARLOTTE-GASTONIA-ROCK HILL, NC-SC	1,091,000	58	33	ND	ND	9	0.017	0.12	0.04
CHARLOTTESVILLE, VA	123,000	53	27	ND	ND	ND	ND	ND	ND
CHATTANOOGA, TN-GA	432,000	75	39	ND	ND	ND	ND	0.12	ND
CHEYENNE, WY	76,000	ND	ND	ND	ND	ND	ND	ND	ND
CHICAGO, IL	6,199,000	149	45	0.01	0.052	6	0.031	0.11	0.13
CHICO, CA	169,000	78	36	ND	ND	9	0.015	0.12	ND
CINCINNATI, OH-KY-IN	1,438,000	108	35	0.017	0.075	5	0.028	0.15	1.22

PM10 = HIGHEST SECOND MAXIMUM 24-HOUR CONCENTRATION (Applicable NAAQS is 150 ug/m3)
= HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 50 ug/m3)
SO2 = HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 0.03 ppm)
= HIGHEST SECOND MAXIMUM 24-HOUR CONCENTRATION (Applicable NAAQS is 0.14 ppm)
CO = HIGHEST SECOND MAXIMUM NON-OVERLAPPING 8-HOUR CONCENTRATION (Applicable NAAQS is 9 ppm)
NO2 = HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 0.053 ppm)
O3 = HIGHEST SECOND DAILY MAXIMUM 1-HOUR CONCENTRATION (Applicable NAAQS is 0.12 ppm)
PB = HIGHEST QUARTERLY MAXIMUM CONCENTRATION (Applicable NAAQS is 1.5 ug/m3)
ND = INDICATES DATA NOT AVAILABLE
IN = INDICATES INSUFFICIENT DATA TO CALCULATE SUMMARY STATISTIC

UGM = UNITS ARE MICROGRAMS PER CUBIC METER
PPM = UNITS ARE PARTS PER MILLION

* - Impact from an industrial source in Leeds, AL. Highest site in Birmingham, AL is 0.17 ug/m3.

- Impact from localized construction activity.

TABLE 4-3. 1990 METROPOLITAN STATISTICAL AREA AIR QUALITY FACTBOOK
PEAK STATISTICS FOR SELECTED POLLUTANTS BY MSA

METROPOLITAN STATISTICAL AREA	1990 POPULATION	PM10 2ND MAX (UGM)	PM10 WTD AM (UGM)	SO2 AM (PPM)	SO2 24-HR (PPM)	CO 8-HR (PPM)	NO2 AM (PPM)	OZONE 2ND MAX (PPM)	PB QMAX (UGM)
CLARKSVILLE-HOPKINSVILLE, TN-KY	157,000	ND	ND	0.007	0.038	ND	ND	ND	ND
CLEVELAND, OH	1,851,000	122	48	0.017	0.08	5	0.029	0.12	0.54
COLORADO SPRINGS, CO	390,000	82	28	ND	ND	7	ND	0.09	0.03
COLUMBIA, MO	107,000	40	IN	IN	0.044	ND	ND	ND	ND
COLUMBIA, SC	451,000	77	30	0.004	0.02	6	0.013	0.11	0.06
COLUMBUS, GA-AL	246,000	63	29	ND	ND	ND	ND	0.11	1.83 *
COLUMBUS, OH	1,320,000	91	35	0.008	0.038	5	IN	0.11	0.41
CORPUS CHRISTI, TX	360,000	78	30	0.002	0.016	ND	ND	0.10	ND
CUMBERLAND, MD-WV	102,000	60	IN	0.01	0.031	5	ND	0.09	ND
DALLAS, TX	2,456,000	88	35	0.006	0.022	5	0.018	0.14	1.62 #
DANBURY, CT	189,000	44	22	0.007	0.033	ND	ND	0.15	ND
DANVILLE, VA	109,000	ND	ND	ND	ND	ND	ND	ND	ND
DAVENPORT-ROCK ISLAND-MOLINE, IA-IL	367,000	90	30	0.006	0.028	4	ND	0.10	0.03
DAYTON-SPRINGFIELD, OH	939,000	72	29	0.006	0.024	4	ND	0.12	0.09
DAYTONA BEACH, FL	332,000	ND	ND	ND	ND	ND	ND	ND	ND
DECATUR, AL	131,000	57	25	ND	ND	ND	ND	ND	ND
DECATUR, IL	125,000	101	34	0.008	0.06	ND	ND	0.09	0.03
DENVER, CO	1,645,000	94	34	0.008	0.028	11	ND	0.11	0.23
DES MOINES, IA	385,000	131	42	ND	ND	6	ND	0.07	ND
DETROIT, MI	4,362,000	114	35	0.018	0.07	6	0.024	0.12	0.08
DOTHAN, AL	130,000	70	31	ND	ND	ND	ND	ND	ND
DUBUQUE, IA	91,000	ND	ND	0.005	0.037	ND	ND	ND	ND
DULUTH, MN-WI	242,000	65	25	0.006	0.059	4	ND	ND	ND
EAU CLAIRE, WI	137,000	ND	ND	ND	ND	ND	ND	0.06	ND
EL PASO, TX	573,000	179	54	0.012	0.06	14	0.017	0.14	0.42
ELKHART-GOSHEN, IN	150,000	ND	ND	ND	ND	ND	ND	ND	ND
ELMIRA, NY	90,000	44	IN	0.005	0.021	ND	ND	0.10	ND
ENID, OK	60,000	ND	ND	ND	ND	ND	ND	ND	ND
ERIE, PA	279,000	71	27	0.014	0.057	5	0.015	0.10	ND
EUGENE-SPRINGFIELD, OR	265,000	142	25	ND	ND	5	ND	0.09	0.02
EVANSVILLE, IN-KY	281,000	84	34	0.02	0.1	3	0.018	0.11	ND
FALL RIVER, MA-RI	153,000	45	20	0.008	0.049	ND	ND	ND	ND
FARGO-MOORHEAD, ND-MN	147,000	63	22	ND	ND	1	ND	ND	ND
FAYETTEVILLE, NC	259,000	56	31	0.003	0.012	7	ND	0.10	ND
FAYETTEVILLE-SPRINGDALE, AR	110,000	59	23	ND	ND	ND	ND	ND	ND
FITCHBURG-LEOMINSTER, MA	96,000	ND	ND	ND	ND	ND	ND	ND	ND
FLINT, MI	435,000	62	26	0.004	0.017	ND	ND	0.10	0.02
FLORENCE, AL	136,000	56	24	0.004	0.03	ND	ND	ND	ND
FLORENCE, SC	117,000	ND	ND	ND	ND	ND	ND	ND	ND
FORT COLLINS, CO	180,000	45	23	ND	ND	7	ND	0.10	ND

FORT LAUDERDALE-HOLLYWOOD-POMPANO B	1,163,000	45	24	ND	ND	5	IN	0.10	0.04
FORT MYERS-CAPE CORAL, FL	295,000	ND	ND	ND	ND	ND	ND	0.08	ND
FORT PIERCE, FL	215,000	ND	ND	ND	ND	ND	ND	ND	ND
FORT SMITH, AR-OK	178,000	55	26	ND	ND	ND	ND	ND	ND
FORT WALTON BEACH, FL	145,000	ND	ND	ND	ND	ND	ND	ND	ND
FORT WAYNE, IN	364,000	87	25	0.004	0.018	5	0.009	0.09	ND
FORT WORTH-ARLINGTON, TX	1,269,000	51	26	0.002	0.008	5	0.012	0.14	0.03
FRESNO, CA	597,000	238	66	0.004	0.015	8	0.026	0.15	ND
GADSDEN, AL	103,000	61	IN	ND	ND	ND	ND	ND	ND
GAINESVILLE, FL	205,000	ND	ND	ND	ND	ND	ND	ND	ND
GALVESTON-TEXAS CITY, TX	211,000	56	IN	0.007	0.063	ND	ND	0.15	0.02
GARY-HAMMOND, IN	604,000	203	40	0.013	0.069	5	0.023	0.12	0.35
GLENS FALLS, NY	112,000	ND	ND	0.005	0.04	ND	ND	ND	ND
GRAND FORKS, ND	70,000	104	25	0.01	0.121	1	IN	ND	ND
GRAND RAPIDS, MI	657,000	84	32	0.004	0.012	4	ND	0.14	0.03
GREAT FALLS, MT	78,000	69	26	ND	ND	6	ND	ND	ND
GREELEY, CO	135,000	66	IN	ND	ND	7	ND	0.11	ND
GREEN BAY, WI	188,000	74	25	0.008	0.037	ND	ND	0.09	ND
GREENSBORO-WINSTON SALEM-HIGH POINT,	916,000	72	33	0.008	0.024	7	0.017	0.12	ND
GREENVILLE-SPARTANBURG, SC	612,000	64	IN	0.002	0.011	ND	IN	0.11	0.05
HAGERSTOWN, MD	116,000	ND	ND	ND	ND	ND	ND	ND	ND
HAMILTON-MIDDLETOWN, OH	276,000	76	27	0.011	0.045	ND	ND	0.13	ND
HARRISBURG-LEBANON-CARLISLE, PA	584,000	59	27	0.007	0.024	7	0.02	0.12	ND
HARTFORD, CT	748,000	61	25	0.009	0.039	9	0.019	0.15	0.04
HICKORY, NC	219,000	ND	ND	0.003	0.01	ND	ND	0.09	ND
HONOLULU, HI	831,000	52	IN	0.001	0.001	3	ND	0.05	0.01
HOUMA-THIBODAUX, LA	185,000	ND	ND	ND	ND	ND	ND	0.12	ND
HOUSTON, TX	3,228,000	82	30	0.009	0.039	8	0.029	0.22	0.04
HUNTINGTON-ASHLAND, WV-KY-OH	323,000	117	35	0.018	0.126	5	0.016	0.14	0.05
HUNTSVILLE, AL	231,000	76	30	ND	ND	4	ND	0.09	ND

PM10 = HIGHEST SECOND MAXIMUM 24-HOUR CONCENTRATION (Applicable NAAQS is 150 ug/m3)
= HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 50 ug/m3)
SO2 = HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 0.03 ppm)
= HIGHEST SECOND MAXIMUM 24-HOUR CONCENTRATION (Applicable NAAQS is 0.14 ppm)
CO = HIGHEST SECOND MAXIMUM NON-OVERLAPPING 8-HOUR CONCENTRATION (Applicable NAAQS is 9 ppm)
NO2 = HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 0.053 ppm)
O3 = HIGHEST SECOND DAILY MAXIMUM 1-HOUR CONCENTRATION (Applicable NAAQS is 0.12 ppm)
PB = HIGHEST QUARTERLY MAXIMUM CONCENTRATION (Applicable NAAQS is 1.5 ug/m3)
ND = INDICATES DATA NOT AVAILABLE
IN = INDICATES INSUFFICIENT DATA TO CALCULATE SUMMARY STATISTIC

UGM = UNITS ARE MICROGRAMS PER CUBIC METER
PPM = UNITS ARE PARTS PER MILLION

* - Impact from an industrial source.

- Impact from an industrial source in Collin County, TX. Highest site in Dallas, TX is 0.36 ug/m3.

TABLE 4-3. 1990 METROPOLITAN STATISTICAL AREA AIR QUALITY FACTBOOK
PEAK STATISTICS FOR SELECTED POLLUTANTS BY MSA

METROPOLITAN STATISTICAL AREA	1990 POPULATION	PM10 2ND MAX (UGM)	PM10 WTD AM (UGM)	SO2 AM (PPM)	SO2 24-HR (PPM)	CO 8-HR (PPM)	NO2 AM (PPM)	OZONE 2ND MAX (PPM)	PB QMAX (UGM)
INDIANAPOLIS, IN	1,229,000	85	38	0.013	0.047	5	0.02	0.11	1.68 *
IOWA CITY, IA	36,000	ND	ND	ND	ND	ND	ND	0.09	ND
JACKSON, MI	147,000	ND	ND	ND	ND	ND	ND	ND	ND
JACKSON, MS	396,000	54	28	ND	ND	5	ND	0.10	0.07
JACKSON, TN	78,000	70	27	ND	ND	ND	ND	ND	ND
JACKSONVILLE, FL	878,000	61	35	0.008	0.13	5	0.015	0.11	0.04
JACKSONVILLE, NC	126,000	47	IN	ND	ND	ND	ND	ND	ND
JAMESTOWN-DUNKIRK, NY	141,000	49	IN	0.012	0.065	ND	ND	0.08	ND
JANESVILLE-BELOIT, WI	135,000	ND	ND	ND	ND	ND	ND	0.09	ND
JERSEY CITY, NJ	547,000	93	30	0.015	0.053	7	0.03	0.18	0.06
JOHNSON CITY-KINGSPORT-BRISTOL, TN-V	443,000	63	32	0.014	0.058	3	0.019	0.12	ND
JOHNSTOWN, PA	252,000	58	28	0.014	0.047	4	0.025	0.10	0.16
JOLIET, IL	377,000	89	30	0.004	0.021	ND	ND	0.09	0.02
JOPLIN, MO	134,000	ND	ND	ND	ND	ND	ND	ND	ND
KALAMAZOO, MI	219,000	ND	ND	ND	ND	ND	ND	ND	0.02
KANKAKEE, IL	98,000	ND	ND	ND	ND	ND	ND	ND	ND
KANSAS CITY, MO-KS	1,546,000	103	43	0.004	0.039	6	0.015	0.11	0.04
KENOSHA, WI	120,000	ND	ND	0.003	0.021	ND	0.01	0.11	ND
KILLEN-TEMPLE, TX	234,000	21	IN	ND	ND	ND	ND	ND	ND
KNOXVILLE, TN	594,000	73	38	0.011	0.044	5	ND	0.12	ND
KOKOMO, IN	101,000	ND	ND	ND	ND	ND	ND	ND	ND
LA CROSSE, WI	95,000	ND	ND	ND	ND	ND	ND	ND	ND
LAFAYETTE, LA	212,000	ND	ND	ND	ND	ND	ND	0.11	ND
LAFAYETTE, IN	125,000	77	IN	IN	0.021	1	ND	0.10	ND
LAKE CHARLES, LA	172,000	44	21	0.003	0.017	ND	ND	0.13	ND
LAKE COUNTY, IL	494,000	ND	ND	ND	ND	ND	IN	0.10	ND
LAKELAND-WINTER HAVEN, FL	387,000	ND	ND	0.004	0.023	ND	ND	ND	ND
LANCASTER, PA	404,000	59	IN	0.006	0.028	3	0.017	0.10	0.06
LANSING-EAST LANSING, MI	428,000	ND	ND	ND	ND	ND	ND	0.10	0.02
LAREDO, TX	124,000	61	IN	ND	ND	ND	ND	ND	ND
LAS CRUCES, NM	129,000	122	43	0.018	0.092	6	ND	0.10	0.17
LAS VEGAS, NV	600,000	162	69	ND	ND	14	0.037	0.11	ND
LAWRENCE, KS	75,000	ND	ND	ND	ND	ND	ND	ND	ND
LAWRENCE-HAVERHILL, MA-NH	375,000	39	IN	0.009	0.035	ND	ND	0.10	ND
LAWTON, OK	119,000	73	IN	0.005	0.019	ND	ND	ND	ND
LEWISTON-AUBURN, ME	85,000	55	25	0.007	0.027	ND	ND	ND	0.02
LEXINGTON-FAYETTE, KY	342,000	61	IN	0.006	0.02	4	0.017	0.11	ND
LIMA, OH	156,000	ND	ND	0.005	0.026	ND	ND	0.10	ND
LINCOLN, NE	208,000	61	29	ND	ND	9	ND	0.07	ND
LITTLE ROCK-NORTH LITTLE ROCK, AR	512,000	68	33	0.003	0.014	ND	0.009	0.10	0.06

LONGVIEW-MARSHALL, TX	167,000	ND	ND	ND	ND	ND	ND	0.13	ND	
LORAIN-ELYRIA, OH	268,000	ND	ND	0.007	0.031	ND	ND	0.09	ND	
LOS ANGELES-LONG BEACH, CA	8,505,000	132	55	0.004	0.014	16	0.056	0.27	0.11	
LOUISVILLE, KY-IN	967,000	76	36	0.012	0.046	7	0.03	0.13	0.05	
LOWELL, MA-NH	260,000	ND	ND	ND	ND	7	ND	ND	ND	
LUBBOCK, TX	228,000	61	24	ND	ND	ND	ND	ND	ND	
LYNCHBURG, VA	143,000	51	24	ND	ND	ND	ND	0.10	ND	
MACON-WARNER ROBINS, GA	283,000	ND	ND	ND	ND	ND	ND	ND	ND	
MADISON, WI	347,000	54	24	0.004	0.018	4	ND	0.08	ND	
MANCHESTER, NH	146,000	47	20	0.01	0.056	5	IN	0.10	0.02	
MANSFIELD, OH	128,000	56	IN	ND	ND	ND	ND	ND	ND	
MAYAGUEZ, PR	210,000	ND	ND	ND	ND	ND	ND	ND	ND	
MCALLEN-EDINBURG-MISSION, TX	379,000	ND	ND	ND	ND	ND	ND	ND	ND	
MEDFORD, OR	143,000	143	45	ND	ND	9	ND	0.10	0.02	
MELBOURNE-TITUSVILLE-PALM BAY, FL	375,000	ND	ND	ND	ND	ND	ND	0.09	ND	
MEMPHIS, TN-AR-MS	972,000	71	32	0.009	0.04	9	0.023	0.12	2.75	#
MERCED, CA	166,000	153	53	ND	ND	ND	ND	ND	ND	
MIAMI-HIALEAH, FL	1,791,000	49	30	0.001	0.003	7	0.016	0.11	0.03	
MIDDLESEX-SOMERSET-HUNTERDON, NJ	966,000	64	29	0.007	0.032	5	0.022	0.15	0.3	
MIDDLETOWN, CT	85,000	44	21	ND	ND	ND	ND	0.16	ND	
MIDLAND, TX	108,000	ND	ND	ND	ND	ND	ND	ND	ND	
MILWAUKEE, WI	1,389,000	94	35	0.007	0.04	6	0.024	0.13	0.08	
MINNEAPOLIS-ST. PAUL, MN-WI	2,336,000	140	34	0.01	0.101	8	0.022	0.10	2.20	@
MOBILE, AL	483,000	64	36	0.008	0.038	ND	ND	0.11	ND	
MODESTO, CA	327,000	141	48	ND	ND	11	0.026	0.12	ND	

PM10 = HIGHEST SECOND MAXIMUM 24-HOUR CONCENTRATION (Applicable NAAQS is 150 ug/m3)
= HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 50 ug/m3)
SO2 = HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 0.03 ppm)
= HIGHEST SECOND MAXIMUM 24-HOUR CONCENTRATION (Applicable NAAQS is 0.14 ppm)
CO = HIGHEST SECOND MAXIMUM NON-OVERLAPPING 8-HOUR CONCENTRATION (Applicable NAAQS is 9 ppm)
NO2 = HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 0.053 ppm)
O3 = HIGHEST SECOND DAILY MAXIMUM 1-HOUR CONCENTRATION (Applicable NAAQS is 0.12 ppm)
PB = HIGHEST QUARTERLY MAXIMUM CONCENTRATION (Applicable NAAQS is 1.5 ug/m3)
ND = INDICATES DATA NOT AVAILABLE
IN = INDICATES INSUFFICIENT DATA TO CALCULATE SUMMARY STATISTIC

UGM = UNITS ARE MICROGRAMS PER CUBIC METER
PPM = UNITS ARE PARTS PER MILLION

* - Impact from an industrial source in Indianapolis, IN. Highest population oriented site in Indianapolis is 0.91 mg/m3.

- Impact from an industrial source in Memphis, TN. Highest population oriented site in Memphis is 0.11 ug/m3.

@ - Impact from an industrial source in Eagan, MN. Highest site in Minneapolis-St. Paul, MN is 0.17 ug/m3

TABLE 4-3. 1990 METROPOLITAN STATISTICAL AREA AIR QUALITY FACTBOOK
PEAK STATISTICS FOR SELECTED POLLUTANTS BY MSA

METROPOLITAN STATISTICAL AREA	1990 POPULATION	PM10 2ND MAX (UGM)	PM10 WTD AM (UGM)	SO2 AM (PPM)	SO2 24-HR (PPM)	CO 8-HR (PPM)	NO2 AM (PPM)	OZONE 2ND MAX (PPM)	PB QMAX (UGM)
MONMOUTH-OCEAN, NJ	957,000	ND	ND	ND	ND	7	ND	0.14	ND
MONROE, LA	146,000	72	30	ND	ND	ND	ND	ND	ND
MONTGOMERY, AL	297,000	60	27	ND	ND	ND	ND	0.10	ND
MUNCIE, IN	121,000	45	IN	ND	ND	ND	ND	ND	ND
MUSKEGON, MI	159,000	ND	ND	ND	ND	ND	ND	0.13	0.02
NAPLES, FL	128,000	ND	ND	ND	ND	ND	ND	ND	ND
NASHUA, NH	172,000	43	20	0.007	0.036	9	ND	0.10	0.02
NASHVILLE, TN	956,000	81	40	0.016	0.102	8	0.012	0.13	2.37 *
NASSAU-SUFFOLK, NY	2,631,000	ND	ND	0.009	0.048	7	0.028	0.14	0.03
NEW BEDFORD, MA	166,000	39	IN	ND	ND	ND	ND	0.13	ND
NEW BRITAIN, CT	147,000	45	21	0.008	0.038	ND	ND	ND	ND
NEW HAVEN-MERIDEN, CT	519,000	157	41	0.014	0.056	7	0.027	0.16	0.08
NEW LONDON-NORWICH, CT-RI	259,000	48	21	0.008	0.029	ND	ND	0.16	ND
NEW ORLEANS, LA	1,321,000	56	32	0.003	0.013	6	0.02	0.11	0.05
NEW YORK, NY	8,529,000	103	37	0.018	0.063	11	0.046	0.16	0.07
NEWARK, NJ	1,891,000	94	37	0.013	0.044	9	0.035	0.13	0.39
NIAGARA FALLS, NY	216,000	53	21	0.011	0.044	3	ND	0.10	ND
NORFOLK-VIRGINIA BEACH-NEWPORT NEWS,	1,346,000	67	28	0.008	0.026	5	0.019	0.11	0.18
NORWALK, CT	126,000	82	39	ND	ND	ND	ND	ND	ND
OAKLAND, CA	1,968,000	118	33	0.003	0.014	6	0.023	0.12	0.13
OCALA, FL	181,000	ND	ND	ND	ND	ND	ND	ND	ND
ODESSA, TX	127,000	36	IN	ND	ND	ND	ND	ND	ND
OKLAHOMA CITY, OK	975,000	59	29	0.004	0.019	7	0.015	0.11	0.04
OLYMPIA, WA	151,000	86	24	ND	ND	ND	ND	ND	ND
OMAHA, NE-IA	616,000	109	44	0.002	0.006	7	ND	0.08	2.96 #
ORANGE COUNTY, NY	288,000	ND	ND	ND	ND	ND	ND	ND	1.35 @
ORLANDO, FL	935,000	55	32	0.002	0.011	5	0.012	0.12	0.01
OWENSBORO, KY	88,000	71	29	0.009	0.038	5	0.011	0.11	0.04
OXNARD-VENTURA, CA	628,000	96	35	0.001	0.008	4	0.025	0.15	ND
PANAMA CITY, FL	122,000	ND	ND	ND	ND	ND	ND	ND	ND
PARKERBURG-MARIETTA, WV-OH	156,000	ND	ND	0.014	0.064	ND	ND	0.11	0.02
PASCAGOULA, MS	128,000	ND	ND	0.006	0.022	ND	ND	0.11	ND
PAWTUCKET-WOONSOCKET-ATTLEBORO, RI-M	322,000	51	IN	0.009	0.037	ND	ND	ND	ND
PENSACOLA, FL	344,000	ND	ND	0.008	0.078	ND	ND	0.12	ND
PEORIA, IL	339,000	72	27	0.008	0.068	7	ND	0.09	0.04
PHILADELPHIA, PA-NJ	4,866,000	89	38	0.016	0.062	7	0.035	0.14	2.95 +
PHOENIX, AZ	1,960,000	127	46	0.003	0.011	10	0.017	0.14	0.06
PINE BLUFF, AR	91,000	47	21	ND	ND	ND	ND	ND	ND
PITTSBURGH, PA	2,105,000	191	43	0.028	0.171 $	8	0.031	0.11	0.05
PITTSFIELD, MA	80,000	ND	ND	ND	ND	ND	ND	0.11	ND

PONCE, PR	235,000	ND	ND	ND	ND	ND	ND	ND	ND
PORTLAND, ME	210,000	48	23	0.009	0.034	ND	0.017	0.13	0.04
PORTLAND, OR-WA	1,168,000	80	27	0.005	0.019	8	IN	0.15	0.11
PORTSMOUTH-DOVER-ROCHESTER, NH-ME	215,000	47	21	0.007	0.025	ND	IN	0.10	0.02
POUGHKEEPSIE, NY	258,000	ND	ND	0.009	0.039	ND	ND	0.12	ND
PROVIDENCE, RI	643,000	78	38	0.012	0.041	7	0.024	0.14	0.06
PROVO-OREM, UT	242,000	127	33	ND	ND	16	0.023	0.09	ND
PUEBLO, CO	127,000	52	IN	ND	ND	ND	ND	ND	ND
RACINE, WI	173,000	ND	ND	ND	ND	6	ND	0.11	ND
RALEIGH-DURHAM, NC	665,000	52	28	ND	ND	10	0.014	0.12	ND
RAPID CITY, SD	80,000	93	29	ND	ND	ND	ND	ND	ND
READING, PA	324,000	61	26	0.009	0.031	6	0.022	0.11	1.31
REDDING, CA	136,000	77	25	ND	ND	2	IN	0.09	ND
RENO, NV	232,000	164	49	ND	ND	11	ND	0.14	ND
RICHLAND-KENNEWICK-PASCO, WA	150,000	382	IN	ND	ND	ND	ND	ND	ND
RICHMOND-PETERSBURG, VA	825,000	68	28	0.012	0.077	5	0.023	0.12	ND
RIVERSIDE-SAN BERNARDINO, CA	2,119,000	278	80	0.007	0.032	7	0.041	0.30	0.05
ROANOKE, VA	224,000	74	39	0.004	0.018	2	0.013	0.09	ND
ROCHESTER, MN	98,000	89	28	0.005	0.029	6	ND	ND	ND
ROCHESTER, NY	979,000	47	21	0.014	0.051	4	ND	0.11	0.03
ROCKFORD, IL	281,000	54	25	ND	ND	7	ND	0.09	0.04
SACRAMENTO, CA	1,336,000	143	42	0.006	0.012	13	0.024	0.16	0.11
SAGINAW-BAY CITY-MIDLAND, MI	404,000	72	30	IN	0.024	3	0.008	ND	0.03
ST. CLOUD, MN	177,000	98	25	0.002	0.009	6	ND	ND	ND
ST. JOSEPH, MO	85,000	104	IN	0.002	0.013	ND	ND	ND	ND

PM10 = HIGHEST SECOND MAXIMUM 24-HOUR CONCENTRATION (Applicable NAAQS is 150 ug/m3)
= HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 50 ug/m3)
SO2 = HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 0.03 ppm)
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CO = HIGHEST SECOND MAXIMUM NON-OVERLAPPING 8-HOUR CONCENTRATION (Applicable NAAQS is 9 ppm)
NO2 = HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 0.053 ppm)
O3 = HIGHEST SECOND DAILY MAXIMUM 1-HOUR CONCENTRATION (Applicable NAAQS is 0.12 ppm)
PB = HIGHEST QUARTERLY MAXIMUM CONCENTRATION (Applicable NAAQS is 1.5 ug/m3)
ND = INDICATES DATA NOT AVAILABLE
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UGM = UNITS ARE MICROGRAMS PER CUBIC METER
PPM = UNITS ARE PARTS PER MILLION

* - Impact from an industrial source in Willamson County, TN. Highest site in Nashville, TN is 0.13 ug/m3.

- Impact from an industrial source in Omaha, NE.

@ - Impact from an industrial source in Orange County, NY.

+ - Impact from industrial sources in Philadelphia, PA. Highest population oriented site in Philadelphia is 0.39 ug/m3.

$ - Impact from a localized industrial source in Pittsburgh, PA.

TABLE 4-3. 1990 METROPOLITAN STATISTICAL AREA AIR QUALITY FACTBOOK
PEAK STATISTICS FOR SELECTED POLLUTANTS BY MSA

METROPOLITAN STATISTICAL AREA	1990 POPULATION	PM10 2ND MAX (UGM)	PM10 WTD AM (UGM)	SO2 AM (PPM)	SO2 24-HR (PPM)	CO 8-HR (PPM)	NO2 AM (PPM)	OZONE 2ND MAX (PPM)	PB QMAX (UGM)
ST. LOUIS, MO-IL	2,458,000	164	82	0.015	0.064	7	0.026	0.13	2.34 *
SALEM, OR	266,000	ND	ND	ND	ND	8	ND	ND	ND
SALEM-GLOUCESTER, MA	258,000	ND	ND	0.01	0.073	ND	ND	ND	ND
SALINAS-SEASIDE-MONTEREY, CA	343,000	53	23	0.001	0.001	3	0.012	0.09	ND
SALT LAKE CITY-OGDEN, UT	1,055,000	125	33	0.019	0.08	10	0.029	0.12	0.09
SAN ANGELO, TX	99,000	ND	ND	ND	ND	ND	ND	ND	ND
SAN ANTONIO, TX	1,307,000	55	28	ND	ND	5	ND	0.10	0.07
SAN DIEGO, CA	2,286,000	70	38	0.005	0.015	8	0.029	0.17	0.13
SAN FRANCISCO, CA	1,590,000	93	34	0.002	0.01	7	0.022	0.06	0.13
SAN JOSE, CA	1,415,000	138	40	ND	ND	11	0.03	0.12	0.09
SAN JUAN, PR	1,541,000	107	32	0.003	0.028	6	ND	0.07	0.03
SANTA BARBARA-SANTA MARIA-LOMPOC, CA	341,000	82	37	0.002	0.01	6	0.022	0.13	ND
SANTA CRUZ, CA	222,000	47	24	0.001	0.003	1	0.008	0.08	ND
SANTA FE, NM	111,000	54	16	0.001	0.003	4	IN	0.08	ND
SANTA ROSA-PETALUMA, CA	354,000	62	19	ND	ND	4	0.015	0.08	0.03
SARASOTA, FL	256,000	60	IN	0.002	0.016	6	ND	0.10	ND
SAVANNAH, GA	241,000	ND	ND	0.002	0.008	ND	ND	ND	ND
SCRANTON-WILKES-BARRE, PA	731,000	64	24	0.01	0.052	5	0.02	0.11	ND
SEATTLE, WA	1,796,000	119	36	0.009	0.026	10	ND	0.13	0.52
SHARON, PA	123,000	68	30	0.01	0.037	ND	ND	0.10	ND
SHEBOYGAN, WI	102,000	ND	ND	0.004	0.032	ND	ND	0.11	ND
SHERMAN-DENISON, TX	100,000	ND	ND	ND	ND	ND	ND	ND	ND
SHREVEPORT, LA	364,000	55	28	0.002	0.006	ND	ND	0.12	ND
SIOUX CITY, IA-NE	115,000	69	28	ND	ND	ND	ND	ND	ND
SIOUX FALLS, SD	124,000	46	20	ND	ND	ND	ND	ND	ND
SOUTH BEND-MISHAWAKA, IN	242,000	96	29	0.006	0.024	3	ND	0.10	ND
SPOKANE, WA	355,000	268	48	ND	ND	12	ND	0.07	ND
SPRINGFIELD, IL	191,000	66	25	0.007	0.053	4	ND	0.10	ND
SPRINGFIELD, MO	229,000	44	23	0.008	0.089	7	0.008	0.08	ND
SPRINGFIELD, MA	517,000	74	29	0.012	0.044	7	0.026	0.12	0.06
STAMFORD, CT	193,000	65	31	0.009	0.046	6	ND	0.14	ND
STATE COLLEGE, PA	115,000	ND	ND	ND	ND	ND	ND	ND	ND
STEUBENVILLE-WEIRTON, OH-WV	149,000	135	43	0.039	0.131	21	0.02	0.09	0.08
STOCKTON, CA	443,000	138	51	ND	ND	11	0.026	0.12	ND
SYRACUSE, NY	647,000	77	33	0.004	0.019	7	ND	0.11	0.03
TACOMA, WA	545,000	140	34	0.009	0.031	8	ND	0.13	0.03
TALLAHASSEE, FL	223,000	ND	ND	ND	ND	ND	ND	ND	ND
TAMPA-ST. PETERSBURG-CLEARWATER, FL	1,965,000	68	32	0.009	0.039	6	0.013	0.11	0.01
TERRE HAUTE, IN	132,000	96	35	0.011	0.042	ND	ND	0.11	ND
TEXARKANA, TX-AR	120,000	48	24	ND	ND	ND	ND	ND	ND

TOLEDO, OH	611,000	59	26	0.007	0.035	6	ND	0.10	0.79
TOPEKA, KS	162,000	66	IN	ND	ND	ND	ND	ND	0.02
TRENTON, NJ	327,000	68	29	0.01	0.043	4	ND	0.14	ND
TUCSON, AZ	619,000	116	46	0.002	0.007	7	0.022	0.10	0
TULSA, OK	733,000	79	27	0.012	0.056	6	0.015	0.12	0.11
TUSCALOOSA, AL	144,000	70	32	ND	ND	ND	ND	ND	ND
TYLER, TX	153,000	48	IN	ND	ND	ND	ND	ND	ND
UTICA-ROME, NY	314,000	36	IN	ND	ND	ND	ND	0.10	ND
VALLEJO-FAIRFIELD-NAPA, CA	404,000	104	33	0.002	0.01	8	0.018	0.10	0.07
VANCOUVER, WA	216,000	69	IN	0.005	0.021	11	ND	0.11	ND
VICTORIA, TX	75,000	ND	ND	ND	ND	ND	ND	0.07	ND
VINELAND-MILLVILE-BRIDGETON, NJ	138,000	ND	ND	0.006	0.024	ND	ND	0.13	ND
VISALIA-TULARE-PORTERVILLE, CA	292,000	207	79	ND	ND	5	0.021	0.14	ND
WACO, TX	189,000	ND	ND	ND	ND	ND	ND	ND	ND
WASHINGTON, DC-MD-VA	3,646,000	83	34	0.015	0.036	8	0.03	0.13	0.08
WATERBURY, CT	213,000	86	34	0.01	0.055	ND	ND	ND	0.59
WATERLOO-CEDAR FALLS, IA	149,000	ND	ND	ND	ND	ND	ND	ND	ND
WAUSAU, WI	111,000	ND	ND	0.009	0.048	ND	ND	ND	ND
WEST PALM BEACH-BOCA RATON-DELRAY BE	790,000	38	20	0.002	0.008	3	0.014	0.09	ND
WHEELING, WV-OH	173,000	95	31	0.026	0.068	9	IN	0.11	0.06
WICHITA, KS	475,000	73	30	ND	ND	7	ND	0.10	0.02
WICHITA FALLS, TX	126,000	56	IN	ND	ND	ND	ND	ND	ND
WILLIAMSPORT, PA	117,000	60	26	0.006	0.025	ND	ND	0.09	ND
WILMINGTON, DE-NJ-MD	559,000	91	33	0.013	0.044	5	0.033	0.14	0.09
WILMINGTON, NC	116,000	61	28	ND	ND	ND	ND	0.09	ND
WORCESTER, MA	410,000	49	23	0.008	0.034	6	0.022	0.12	ND
YAKIMA, WA	183,000	100	IN	ND	ND	7	ND	ND	ND
YORK, PA	404,000	63	30	0.007	0.023	4	0.022	0.12	ND
YOUNGSTOWN-WARREN, OH	503,000	85	33	0.01	0.04	ND	ND	0.10	ND
YUBA CITY, CA	116,000	88	39	ND	ND	ND	ND	0.09	ND
YUMA, AZ	93,600	ND	ND	ND	ND	ND	ND	0.09	ND

PM10 = HIGHEST SECOND MAXIMUM 24-HOUR CONCENTRATION (Applicable NAAQS is 150 ug/m3)
= HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 50 ug/m3)
SO2 = HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 0.03 ppm)
= HIGHEST SECOND MAXIMUM 24-HOUR CONCENTRATION (Applicable NAAQS is 0.14 ppm)
CO = HIGHEST SECOND MAXIMUM NON-OVERLAPPING 8-HOUR CONCENTRATION (Applicable NAAQS is 9 ppm)
NO2 = HIGHEST ARITHMETIC MEAN CONCENTRATION (Applicable NAAQS is 0.053 ppm)
O3 = HIGHEST SECOND DAILY MAXIMUM 1-HOUR CONCENTRATION (Applicable NAAQS is 0.12 ppm)
PB = HIGHEST QUARTERLY MAXIMUM CONCENTRATION (Applicable NAAQS is 1.5 ug/m3)
ND = INDICATES DATA NOT AVAILABLE
IN = INDICATES INSUFFICIENT DATA TO CALCULATE SUMMARY STATISTIC

UGM = UNITS ARE MICROGRAMS PER CUBIC METER
PPM = UNITS ARE PARTS PER MILLION

* - Impact from a lead smelter in Herculaneum, MO. Highest site in St. Louis is 0.23 ug/m3.

5. SELECTED METROPOLITAN AREA TRENDS

This chapter discusses 1981-90 air quality trends in fifteen major urban areas: the ten EPA Regional Offices (Boston, New York, Philadelphia, Atlanta, Chicago, Dallas, Kansas City, Denver, San Francisco and Seattle) and five additional cities (Detroit, Houston, Los Angeles, Pittsburgh and Washington, DC.)

The presentation of urban area trends includes maps of the urban area showing major roadways and rivers, county boundaries and the urbanized area. These maps show the location of the current air quality monitoring networks and indicate the sites used in the trend analysis. To complement the map and show the general orientation of the ambient monitoring network with respect to wind flow patterns, a wind rose is presented. The wind rose shows the direction the winds came from during June, July and August, emphasizing the ozone season. Also, three graphical displays are used to depict urban air quality trends. One graph uses the Pollutant Standards Index (PSI) as the measure of air quality. The other two graphs include temperature and display average levels for CO and O_3.

The air quality data used for the trend statistics were obtained from the EPA Aerometric Information Retrieval System (AIRS). This year's report presents trends in the PSI, used locally in many areas to characterize and publicly report air quality. The new PSI analyses are based on daily maximum statistics from selected monitoring sites. The urban area trends for CO and O_3 use the same annual validity and site selection criteria that were used for the national trends. It should be noted that no interpolation is used in this chapter; this corresponds with typical PSI reporting.

5.1 The Pollutant Standards Index

The PSI is used in this section as an air quality indicator for describing urban area trends. Only CO and O_3 monitoring sites had to satisfy the trends selection criteria discussed in Section 2.1 to be included in these PSI trend analyses. Data for other pollutants were used without applying this historical trends criterion, except for SO_2 in Pittsburgh because this pollutant contributed a significant number of days in the high PSI range. Results for individual years could be somewhat different if data from all monitoring sites and all pollutants were considered in an area. This is illustrated for 1990, where the number of PSI days from all monitoring sites is compared to the results for the subset of trend sites.

The PSI has found widespread use in the air pollution field to report daily air quality to the general public. The index integrates information from many pollutants across an entire monitoring network into a single number that represents the worst daily air quality experienced in the urban area. The PSI is computed for PM-10, SO_2, CO, O_3 and NO_2 based on their short-term National Ambient Air Quality Standards (NAAQS), Federal Episode Criteria and Significant Harm Levels. Lead is the only criteria pollutant not included in the

Table 5-1. PSI Categories and Health Effect Descriptor Words

INDEX RANGE	DESCRIPTOR WORDS
0 to 50	Good
51 to 100	Moderate
101 to 199	Unhealthful
200 to 299	Very Unhealthful
300 and Above	Hazardous

index because it does not have a short-term NAAQS, a Federal Episode Criteria or a Significant Harm Level.

The PSI converts daily monitoring information into a single measure of air quality by first computing a separate sub-index for each pollutant with data for the day. The PSI index value used in this analysis represents the highest of the pollutant sub-index values for all sites selected for the MSA. Local agencies may use only selected monitoring sites to determine the PSI value so that differences are possible between the PSI values reported here and those done by the local agencies.

The PSI simplifies the presentation of air quality data by producing a single dimensionless number ranging from 0 to 500. The PSI uses data from all selected sites in the MSA and combines different air pollutants with different averaging times, different units of concentration, and more importantly, with different NAAQS, Federal Episode Criteria and Significant Harm Levels. Table 5-1 shows the 5 PSI categories and health effect descriptor words. The PSI is primarily used to report the daily air quality of a large urban area as a single number or descriptor word. Frequently, the index is reported as a regular feature on local TV or radio news programs or in newspapers.

Throughout this section, emphasis is placed on CO and O_3 which cause most of the NAAQS violations in urban areas.

5.2 Summary of PSI Analyses

Table 5-2 shows the trend in the number of PSI days greater than 100 (unhealthful or worse days). The impact of the very hot and dry summers in 1983 and 1988 in the eastern United States on O_3 concentrations can clearly be seen. Pittsburgh is the only city where a significant number of PSI days greater than 100 are due to pollutants other than CO or O_3. For Pittsburgh, SO_2 and PM-10 account for the additional days. The two right most columns show the number of currently active monitoring sites and the corresponding total number of PSI days > 100, using these sites. Note that for all urban areas except Houston, New York and Seattle there is close agreement between both statistics for 1990. The differences are attributed to currently active sites without sufficient historical data to be used for trends.

For all practical purposes CO, O_3, PM-10 and SO_2 are the only pollutants that contribute to the PSI in these analyses. NO_2 rarely is a factor because it does not have a short-term NAAQS and can only be included when concentrations exceed one of the Federal Episode Criteria or Significant Harm levels. TSP is not included in the index because the revised particulate matter NAAQS is for PM-10, not TSP. As noted above, lead is the only criteria pollutant not included in the index because it does not have a short-term NAAQS or Federal Episode Criteria and Significant Harm Levels.

Table 5-3 shows the trend in the number of PSI days greater than 100 (unhealthful or worse) due to O_3. The only 3 areas where O_3 did not account for most of these days were: Denver, New York City and Pittsburgh. In Denver and New York City, CO accounted for a larger number of these days. However, because of the overall improvement in CO levels (see Section 3.3 in this report), CO accounts for far less of these days in the latter half of the 10-year period. Overall, 72% of the PSI greater than 100 days were due to O_3. In Pittsburgh SO_2 and PM-10 contribute a significant number of these days with PSI greater than 100.

Figure 5-1 is a bar chart showing the number of PSI days above 100 in 1988, 1989 and 1990 for fourteen of the cities being studied. To permit better scaling, Los Angeles is not shown on the graph but the values were 228, 213 and 163 for 1988, 1989 and 1990 respectively. This comparison uses all the monitoring sites available in an area for the 3 years. The use of all sites explains why these figures may not agree with Table 5-2, where only the CO and O_3 sites that met the trend criteria were used. In most cases, there

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Note: Urban lead concentrations have dropped dramatically over the past 15 or so years (See Chapter 3). As a result, only 10 urban areas violated the lead NAAQS based upon 1990 data only. Dallas and Philadelphia are the only two of the 15 urban areas that have a 1990 lead violation. In Dallas, the problem occurred near a smelter located outside of Dallas County, in adjoining Collin County. In Philadelphia, the problem occurred near a smelting and a materials handling operation.

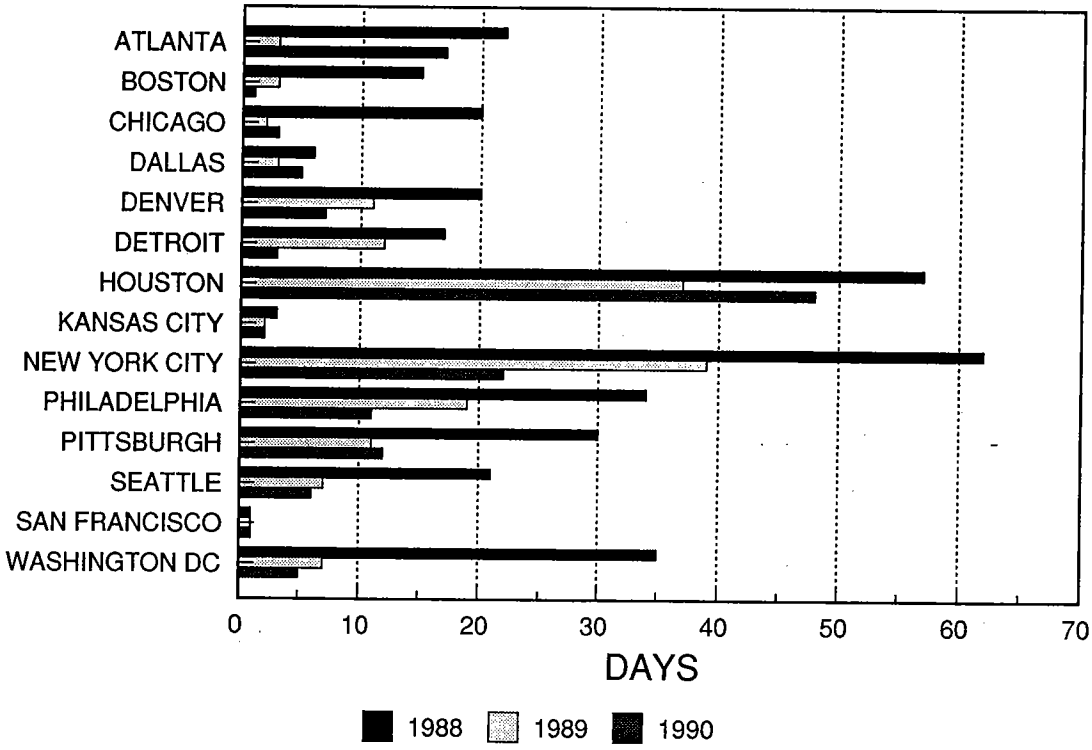
Table 5-2. Number of PSI Days Greater Than 100 at Trend Sites, 1981-90, and All Sites in 1990.

Number of PSI Days Greater than 100 at Trend Sites												All active monitoring sites in PMSA 1990	
		YEAR											
PMSA	# trend sites	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	total # sites	PSI > 100
ATLANTA	3	9	5	23	8	9	17	19	15	3	16	12	17
BOSTON	3	2	5	16	6	2	0	5	11	1	1	26	1
CHICAGO	6	3	3	14	8	6	4	9	18	2	3	42	3
DALLAS	3	12	11	17	10	12	5	6	3	3	5	19	5
DENVER	4	51	52	67	59	37	43	34	18	11	7	17	7
DETROIT	9	18	19	18	7	2	6	9	17	12	3	21	3
HOUSTON	5	34	25	43	30	30	28	31	31	19	35	17	48
KANSAS CITY	7	7	0	4	12	4	8	5	3	2	2	21	2
LOS ANGELES	13	228	195	184	208	196	210	187	226	212	163	21	163
NEW YORK	8	100	69	65	53	21	16	16	35	9	10	24	22
PHILADELPHIA	15	29	44	56	31	25	21	36	34	19	11	29	11
PITTSBURGH	12	17	14	36	24	6	9	15	30	11	12	36	12
SAN FRANCISCO	3	1	2	4	2	5	4	1	1	0	1	5	1
SEATTLE	7	42	19	19	4	26	18	13	8	4	2	23	6
WASHINGTON	14	23	25	53	30	15	11	23	34	7	5	32	5
TOTAL	112	576	488	619	492	396	400	409	484	315	276	345	306

Table 5-3. (Ozone Only) Number of PSI Days Greater Than 100 at Trend Sites, 1981-90, and All Sites in 1990.

Number Of PSI Days Greater Than 100 At All Ozone Trend Sites YEAR												All active O3 monitoring sites in PMSA 1990	
PMSA	O3 trend sites	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	total O3 sites	PSI > 100
ATLANTA	2	9	3	23	8	9	17	19	15	3	16	4	17
BOSTON	1	0	3	10	6	2	0	4	11	1	1	5	1
CHICAGO	5	3	3	12	6	6	2	9	15	1	0	13	0
DALLAS	2	12	11	17	10	11	5	6	3	3	5	4	5
DENVER	2	4	4	11	1	0	1	4	3	0	0	6	0
DETROIT	8	12	17	16	4	1	3	6	16	10	3	9	3
HOUSTON	4	33	22	43	30	30	26	29	31	19	35	13	48
KANSAS CITY	5	4	0	4	11	3	3	2	3	1	2	6	2
LOS ANGELES	13	152	133	142	154	153	159	146	165	137	116	20	117
NEW YORK	5	21	20	33	16	13	6	14	30	5	8	6	13
PHILADELPHIA	10	22	33	52	22	25	19	32	34	17	11	10	11
PITTSBURGH	5	9	4	15	0	2	2	7	21	4	0	9	0
SAN FRANCISCO	2	1	0	2	0	1	0	0	0	0	0	4	1
SEATTLE	1	1	0	0	0	0	1	0	1	0	2	4	4
WASHINGTON	11	12	19	38	12	12	9	18	33	4	5	12	5
TOTAL	76	295	272	418	280	268	253	296	381	205	204	125	227

FIGURE 5-1. PSI DAYS>100 IN 1988, 1989 AND 1990 USING ALL SITES



* NOTE: Los Angeles not shown because of scaling problem.
See Table 5-2 for the PSI>100 days in Los Angeles.

Figure 5-1. PSI days > 100 in 1988, 1989 and 1990 using all sites.

has been a reduction in the frequency of these days between 1988 and 1990. For the eastern and mid-western cities, meteorological conditions during the summer of 1988 were very favorable for O_3 formation. Nationally, the summer of 1988 was the third hottest on record since 1931. Even some of the western cities, e.g. Los Angeles, Denver and Seattle, follow this pattern too.

The pollutant having the highest sub-index value, from all the monitoring sites considered in an MSA, becomes the PSI value used for that day. PSI estimates depend upon the number of pollutants monitored and the number of monitoring sites collecting data. The more pollutants and sites that are available in an area, the better the estimate of the maximum PSI for that day is likely to be. Ozone accounts for most of the days with a PSI above 100 and O_3 air quality is relatively uniform over large areas so that a small number of sites can still estimate maximum pollutant concentrations. All of the included cities had at least one CO trend site and one O_3 trend site. Table 5-4 separately shows the number of CO and O_3 trend sites used in each of the MSA's. In addition, 8 SO_2 trend sites were used in Pittsburgh because SO_2 accounted for a sizeable number of days when the PSI was greater than 100. In Table 5-4, the months corresponding to the O_3 season in the 15 areas are also provided. The PSI trend analyses are presented for the Primary MSA (PMSA) in each city studied, not the larger Consolidated Metropolitan Statistical Area (CMSA). Using the principal PMSA limits the geographical area studied and emphasizes the area having the highest population density. The PMSA monitors are in the core of the urban area; there are typically additional sites in surrounding areas. For example, while there are 21 active monitoring sites in the Los Angeles PMSA in 1990, there are more than 30 monitors for ozone alone in the larger metropolitan area.

Table 5-4. Number of Trend Monitoring Sites for the 15 Urban Area Analyses

Primary Metropolitan Statistical Area (PMSA)	CO Sites	O_3 Sites	O_3 Season
Atlanta, GA	1	2	MAR - NOV
Boston, MA	2	1	APR - OCT
Chicago, IL	3	5	APR - OCT
Dallas, TX	1	2	MAR - OCT
Denver, CO	4	2	MAR - SEP
Detroit, MI	6	8	APR - OCT
Houston, TX	3	4	JAN - DEC
Kansas City, MO-KS	3	5	APR - OCT
Los Angeles, CA	11	13	JAN - DEC
New York, NY	3	5	APR - OCT
Philadelphia, PA	9	10	APR - OCT
Pittsburgh, PA	3	5	APR - OCT
San Francisco, CA	3	2	JAN - DEC
Seattle, WA	6	1	APR - OCT
Washington, DC-MD-VA	10	11	APR - OCT

There are several assumptions that are implicit in the PSI analysis. Probably the most important is that the monitoring data available for a given area provide a reasonable estimate of maximum short-term concentration levels. The PSI procedure uses the maximum concentration which may not represent the air pollution exposure for the entire area. If the downwind maximum concentration site for ozone is outside the PMSA, these data are not used in this analysis. Finally, the PSI assumes that synergism does not exist between pollutants. Each pollutant is examined independently. Combining pollutant concentrations is not possible at this time because the synergistic effects are not known.

5.3 Description of Graphics

Each of the fifteen cities has all of the graphics and explanatory text presented on facing pages. The first page includes a map of the area highlighting the location of the current ambient monitoring network within the PMSA as well as other important features like rivers, lakes and major highways. At each site, the shaded pie wedges of a circle identify the pollutants monitored in 1990. Circles with four tick marks indicate trend sites.

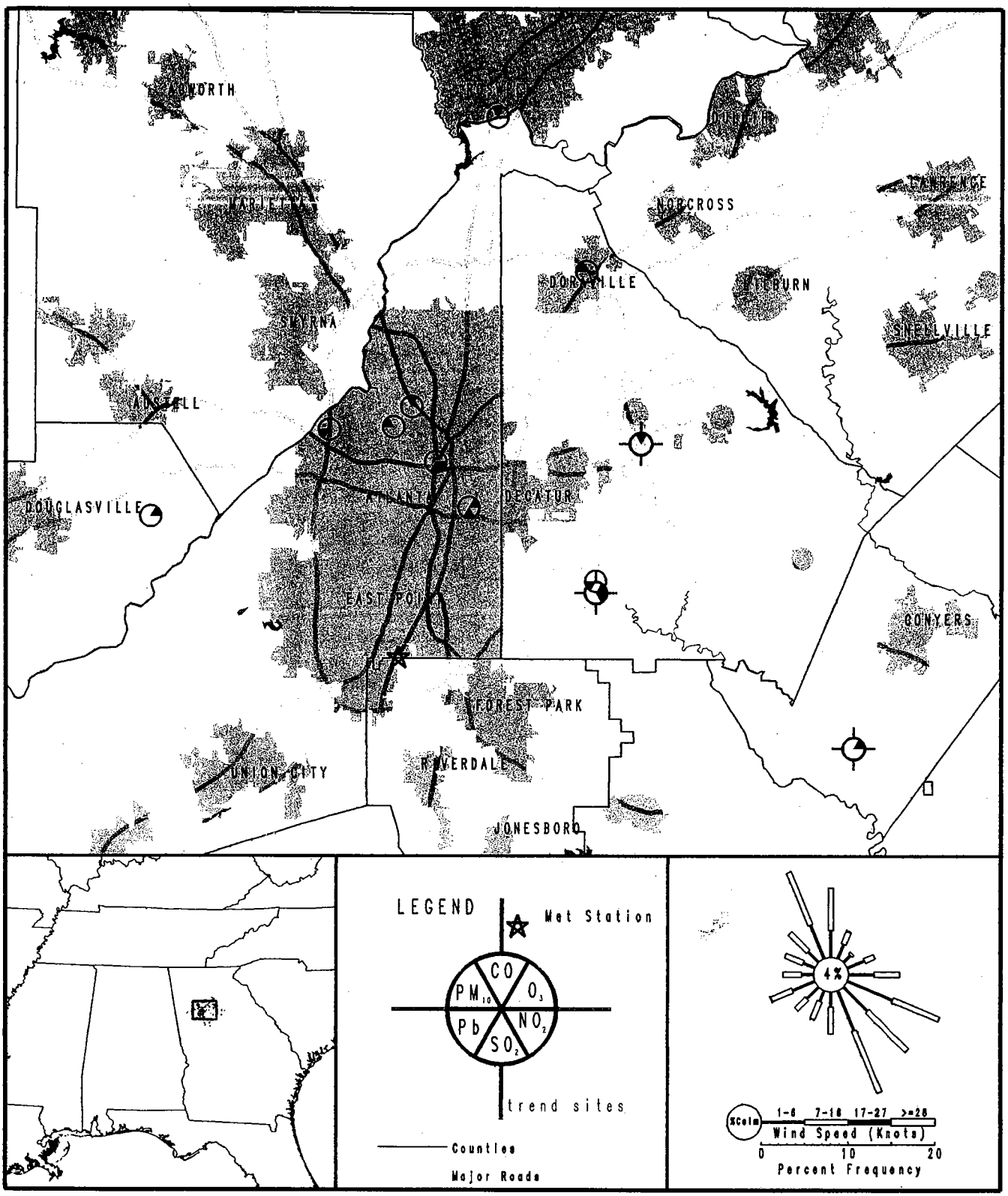
Below each map is an inset showing the location of each area, a legend describing the sites and a wind rose. The legend identifies the shaded

wedges corresponding to particular pollutants. The pollutants (CO, O_3 and PM-10) appear on the upper half of the circle, while the other pollutants (lead, SO_2 and NO_2) are on the lower half. The wind rose shows the frequency of hourly wind direction measurements for June, July and August of calendar year 1990. This corresponds to the principal part of the ozone season. The wind direction refers to the direction the wind is blowing from. The wind data comes from one of the National Oceanographic and Atmospheric Administration (NOAA) meteorological observation stations in the area, usually located at the principal airport.

The accompanying graphs are based on the PSI methodology described earlier. The PSI graphs feature a bar chart which shows the number of PSI days in four PSI categories: 0-50, 51-100, 101-199 and $\geq$200. Table 5-1 shows the PSI descriptor words associated with these categories. The last 2 PSI categories (very unhealthful and hazardous) were combined because there were so few hazardous days reported. The total number of unhealthful, very unhealthful and hazardous days is used to indicate trends. These days are sometimes referred to as the days when the PSI is greater than 100. It is important to note that a PSI of 100 means that the pollutant with the highest sub-index value is at the level of its NAAQS. Because of numerical rounding, the number of days with PSI > 100 does not necessarily correspond exactly to the number of NAAQS exceedances.

CO and O_3 trends are shown on separate plots incorporating information on temperature. CO trends are displayed in terms of the daily maximum 8-hour average data. These averages are also shown for two different categories: days with minimum temperatures greater than 40 degrees and those less than or equal to 40 degrees Fahrenheit. Maximum daily temperatures are used for O_3. The O_3 plots show the trend in average daily maximum 1-hour concentrations for three categories during the O_3 season: 1.) the ten highest O_3 concentration days, 2.) the days when the maximum temperature was 80° F or more and 3.) for all days. The average maximum temperature on the days with the ten highest ozone values are shown as bars in the background of these graphs. The O_3 season for each of these areas is shown in Table 5-4. These plots are an attempt to indicate the impact of temperature, an important meteorological variable. Ozone levels are highest in the summer, especially on very hot stagnant days, while CO is highest usually in the winter months. The New York MSA is one exception; it appears that higher temperatures are associated with higher CO levels. The winter, spring, summer and fall seasons that are referred to correspond respectively to the following months: December-February, March-May, June-August and September-November.

A simple nonparametric test was used to determine the statistical significance of the trends. This test correlated the ranks of the pollution variable, either the number of days that the PSI was above 100 or the average of CO or O_3 in various temperature categories, with the corresponding rank of year. The magnitude of the observed correlation, known as the Spearman correlation coefficient(Rs), indicates the strength of the trend. Coefficients near 1 signify a close agreement between the ranks; whereas, coefficients near 0 signify no agreement. When a trend is said to be significant, it is understood to be significant at the 0.10 level. Correlations that are referred to as significant mean that the correlation is significantly different from 0. The strength of the correlation between average temperature and O_3 levels on the ten highest O_3 days was also examined. The following sections present the metropolitan areas analyses.


ACWORTH
MARIETTA
SMYRNA
AUSTELL
DOUGLASVILLE
ATLANTA
EAST POINT
DECATUR
DORAVILLE
NORCROSS
TUCKER
STONE MOUNTAIN
LITHONIA
CONYERS
SNELLVILLE
FOREST PARK
RIVERDALE
UNION CITY
JONESBORO
LEGEND
Met Station
CO
O3
NO2
SO2
Pb
PM10
trend sites
Counties
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Calm
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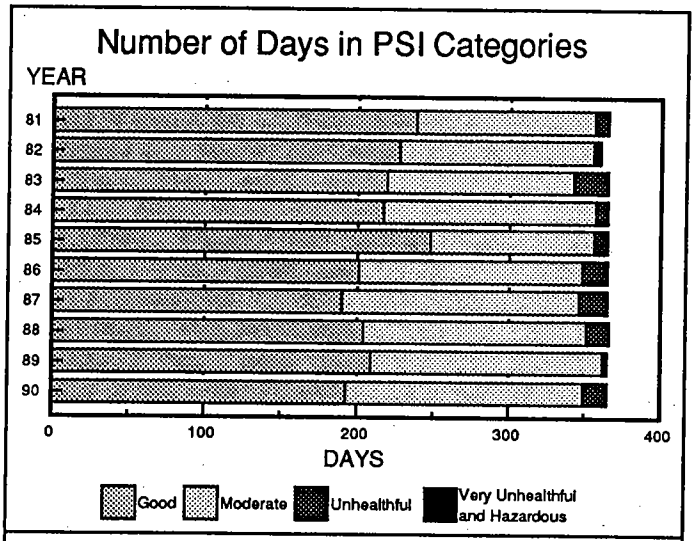
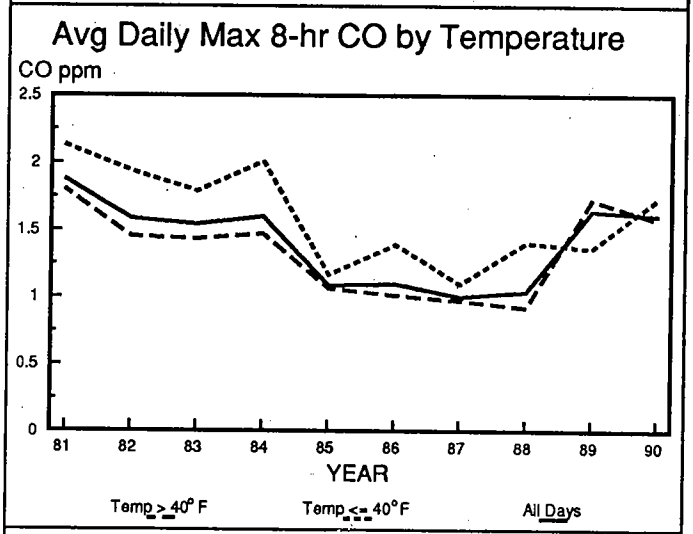
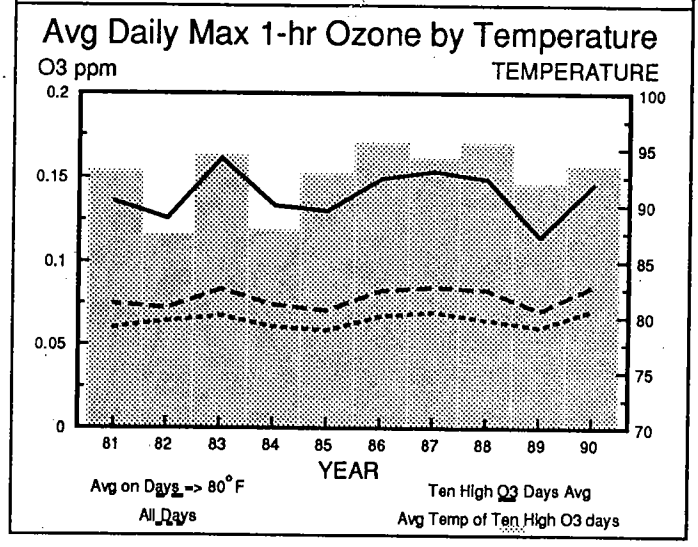
7-18
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency





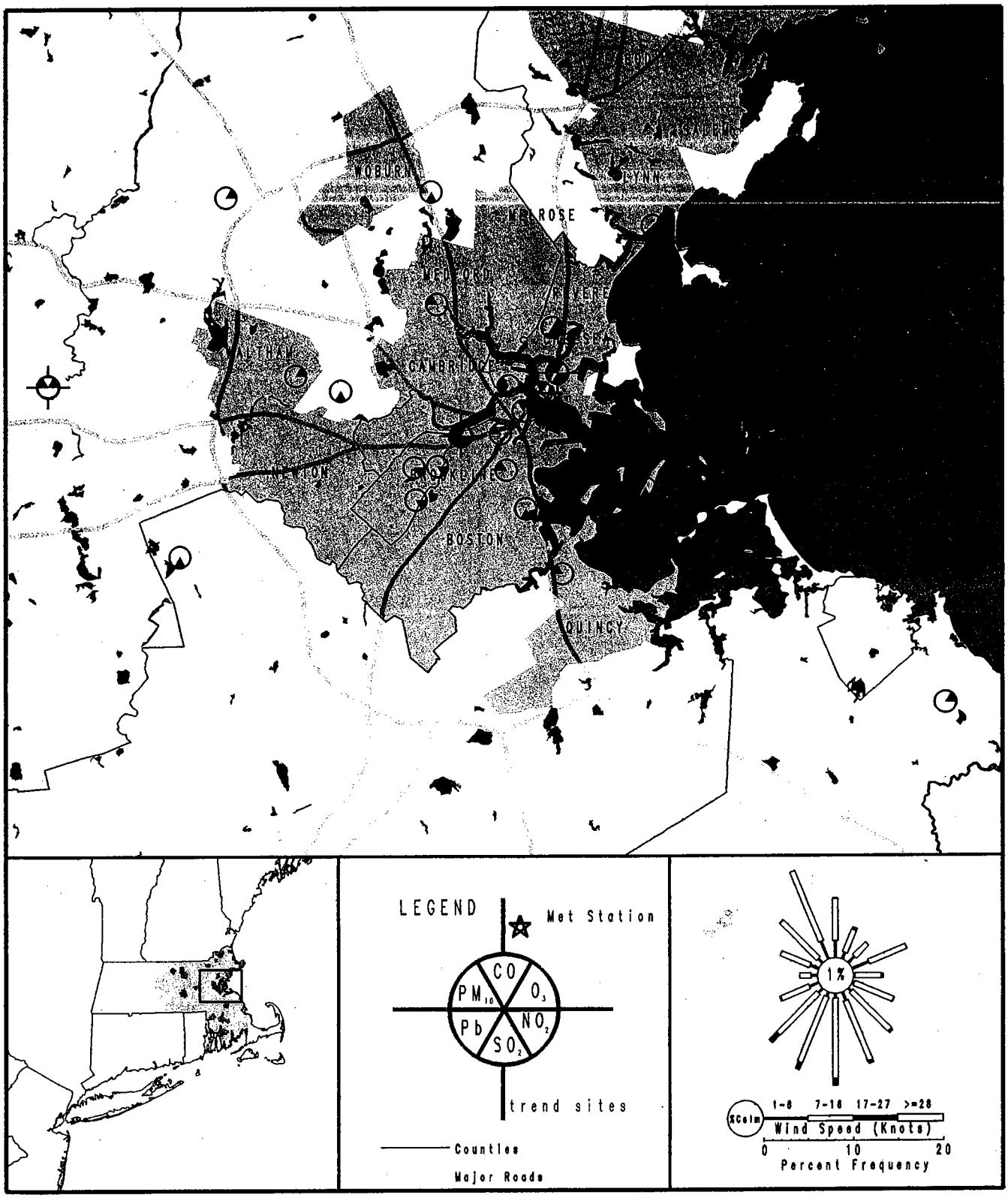


Atlanta, GA

The Atlanta PMSA consists of 18 counties, with most of the people living in Fulton, De Kalb and Cobb Counties. The estimated 1987 population was 2.7 million. Its size and summertime meteorology contribute to the area's air pollution potential. The Bermuda High has a dominant effect on Atlanta's air quality, especially during the summer when the hot stagnant days are conducive to O_3 formation. The map shows 12 currently active monitoring sites.

The PSI trend for Atlanta is based on 3 sites: 1 for CO and 2 for O_3. The CO site is a population exposure site located in De Kalb County. The O_3 sites are a maximum concentration site in Rockdale County and a population exposure site in De Kalb County. Ozone is the pollutant in Atlanta that accounts for all but 2 of the unhealthful days. The number of days with an unhealthful or worse rating varied from 23 days in 1983 to a low of 3 days in 1989. In 1990 there were 16 of these days, all due to O_3. A trend test did not show a significant trend in these days. In the 10-year period only 1 day (in 1987) had a value in the very unhealthful range; no hazardous days were reported.

Average CO concentrations have dropped slightly in both temperature classes. Since 1987 or 1988, CO levels have increased but still meet EPA's standard. The upturn in 1989 in the higher temperature category results from higher CO levels in the August-December period. CO levels average 3 times higher in this period compared to the other months in 1989. Levels of CO averaged 19% higher on the colder days. The O_3 trend in the ten highest O_3 days, the days with temperatures greater or equal to 80° F and for all days all show little change. A trend test was not significant for any of the O_3 averages. Unlike many eastern cities, 1988 average daily maximum temperatures on the ten highest O_3 days were not unusually high. The average daily maximum temperature and O_3 levels on these days tracked well and were significantly correlated.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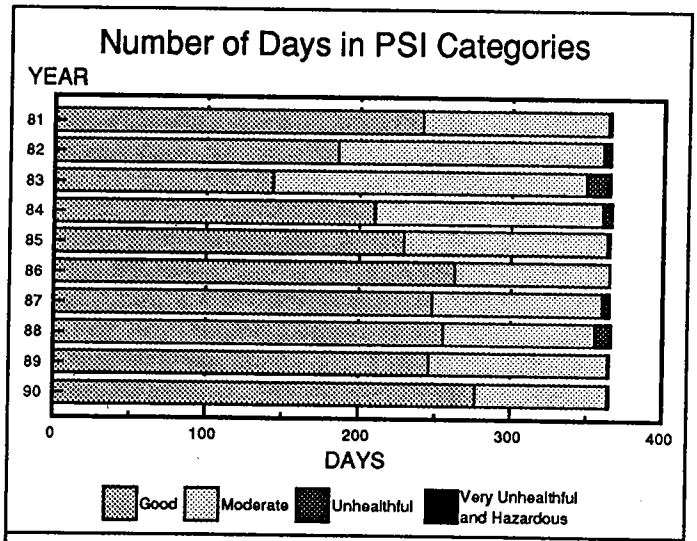
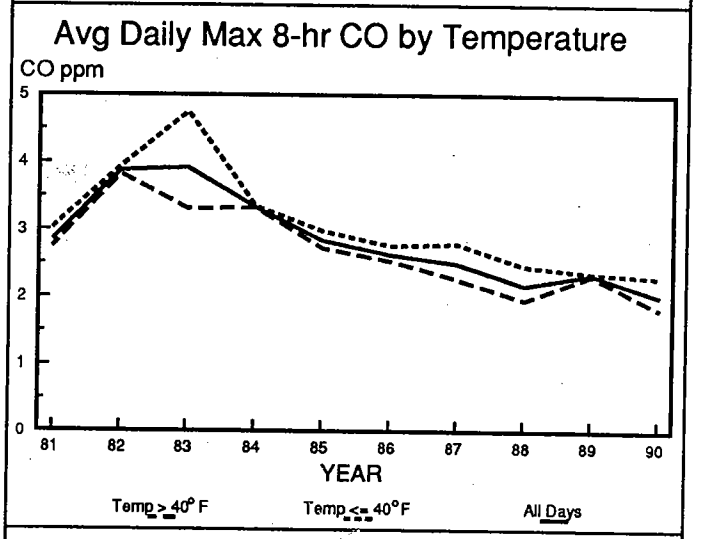
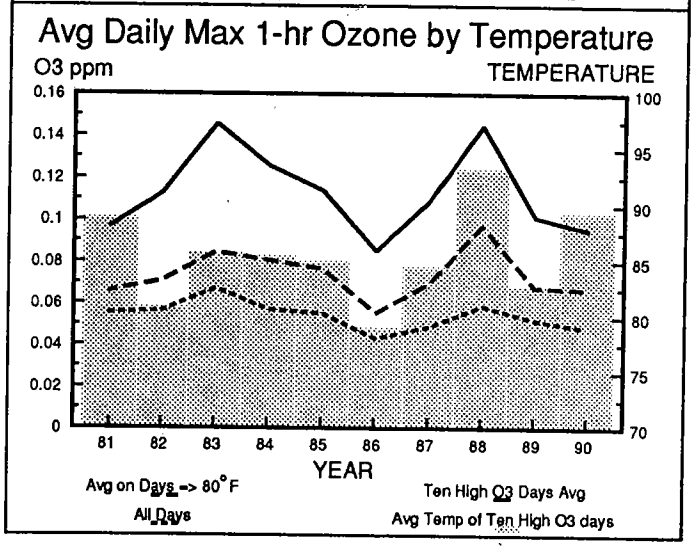
MELROSE
CAMBRIDGE
BOSTON
QUINCY
LEGEND
Met Station
CO
O_3
NO_2
SO_2
Pb
PM_{10}
trend sites
Counties
Major Roads
Calm
1-6
7-16
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency







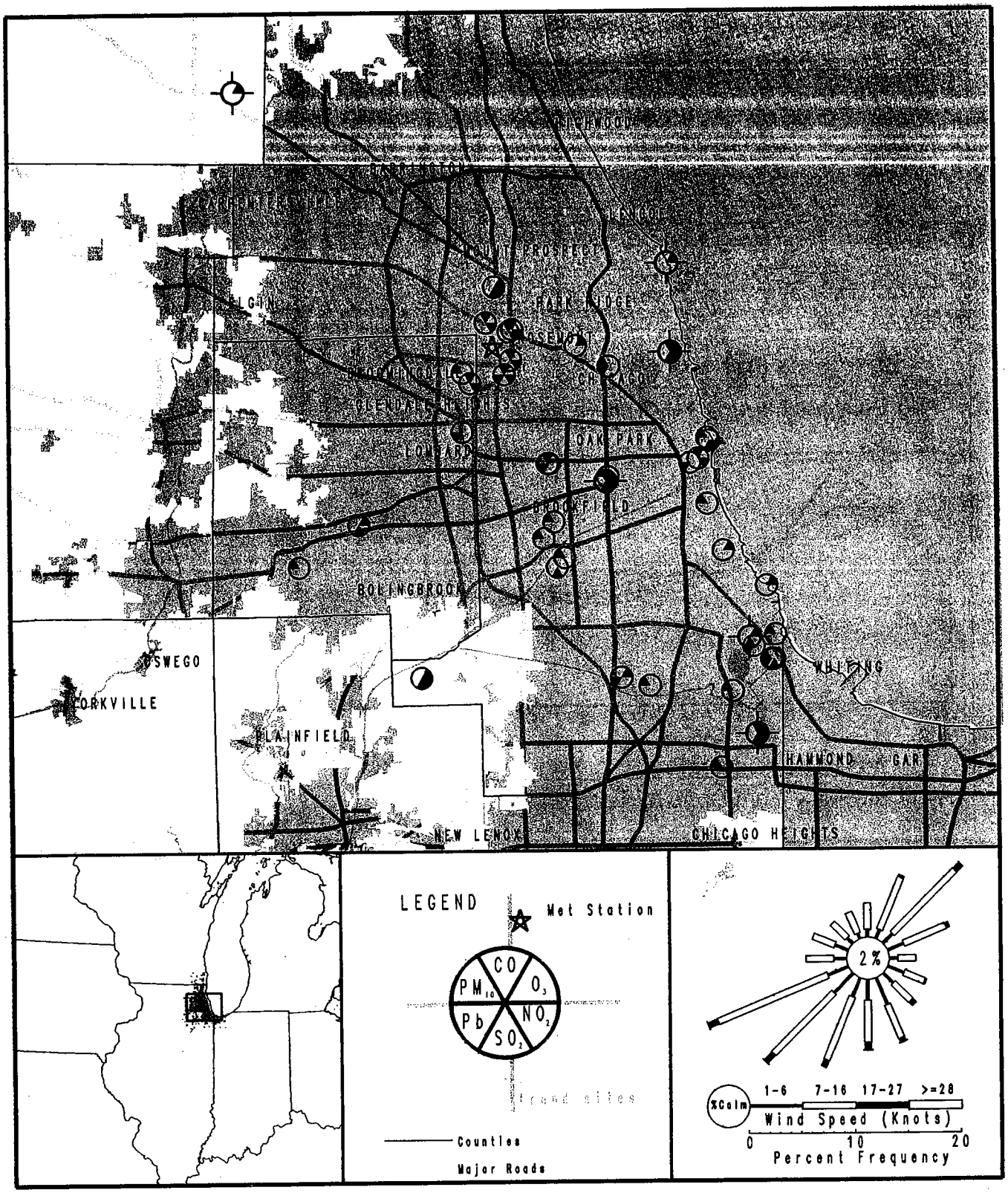
Boston, MA

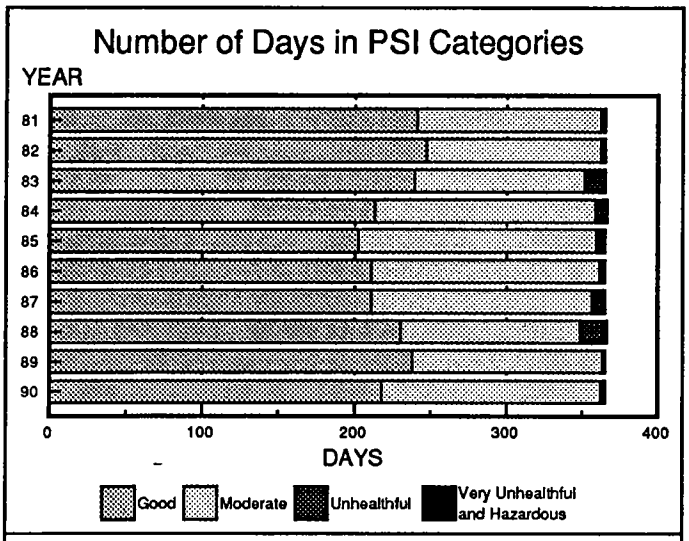
The Boston PMSA consists of Suffolk County and parts of 6 other counties. The estimated 1987 population was 2.8 million. Its size and location as a part of the eastern seaboard megalopolis contribute to the area's air pollution potential. There are 26 currently active monitoring sites in this PMSA.

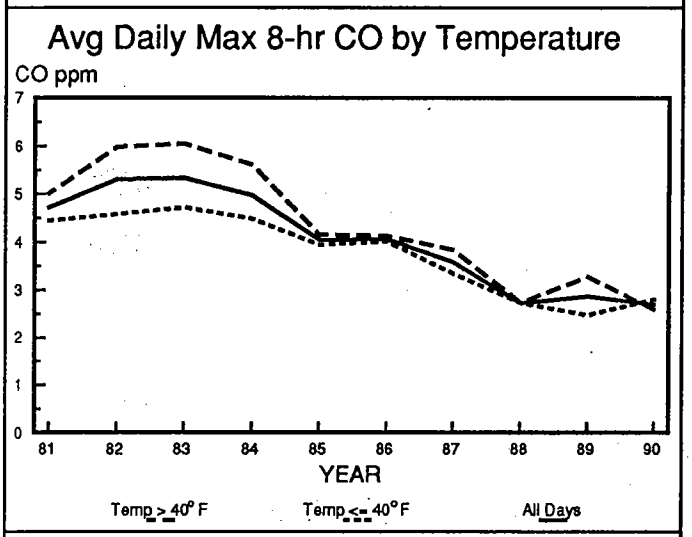
The PSI trend for Boston is based on 3 sites: 2 for CO and 1 for O_3. The CO sites are a maximum concentration site located at Kenmore Square and a NAMS neighborhood scale site located in east Boston. The O_3 site is a maximum concentration site in Sudbury (Middlesex County). The number of PSI days > 100 fluctuates primarily due to O_3. This can be seen particularly in 1988 when the very hot summer caused an increase in these days. Thirty-eight(78%) of the 49 unhealthful or worse days reported are due to O_3. In 1990 there was one day with a PSI value above 100. In the entire 10-year period, only 1 day (in 1983) had a value in the very unhealthful range. There were no hazardous days reported.

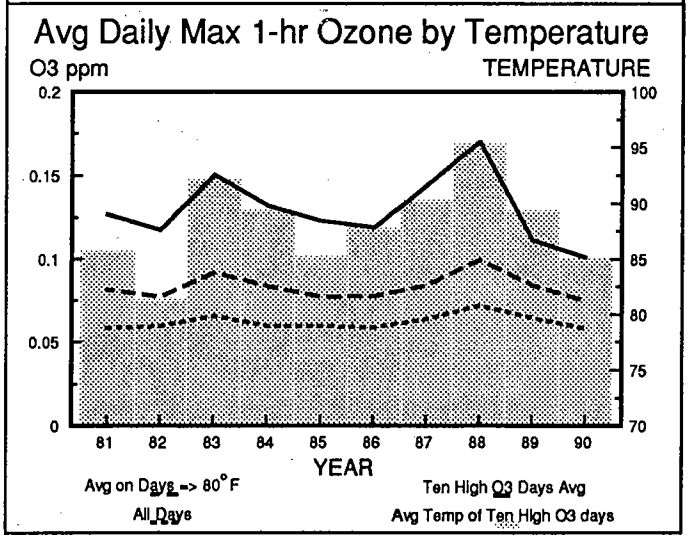
Average CO levels declined in both temperature categories. The trend is significant in both of these cases and for all days as well. Average CO levels over the 10-year period are 15% higher on the colder days.

Average O_3 concentrations show no clear long-term trend for the ten highest O_3 days, the days with maximum temperature equal or greater than 80° F and all days during the O_3 season. Trend tests were not significant for any of these averages. The impact of the hot and dry 1983 and 1988 summers are apparent in the O_3 plot. Average daily maximum temperature and O_3 levels on the ten highest O_3 days do not relate well. The correlation between these two variables was not significant. However, the highest average daily maximum temperature and second highest O_3 average occurred in 1988.


ELK GROVE
PARK RIDGE
OAK PARK
BROOKFIELD
BOLINGBROOK
OSWEGO
YORKVILLE
PLAINFIELD
NEW LENOX
CHICAGO HEIGHTS
HAMMOND
GARY
LEGEND
Met Station
CO
O3
NO2
SO2
Pb
PM10
Trend sites
Counties
Major Roads
2%
%Calm
1-6
7-16
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency







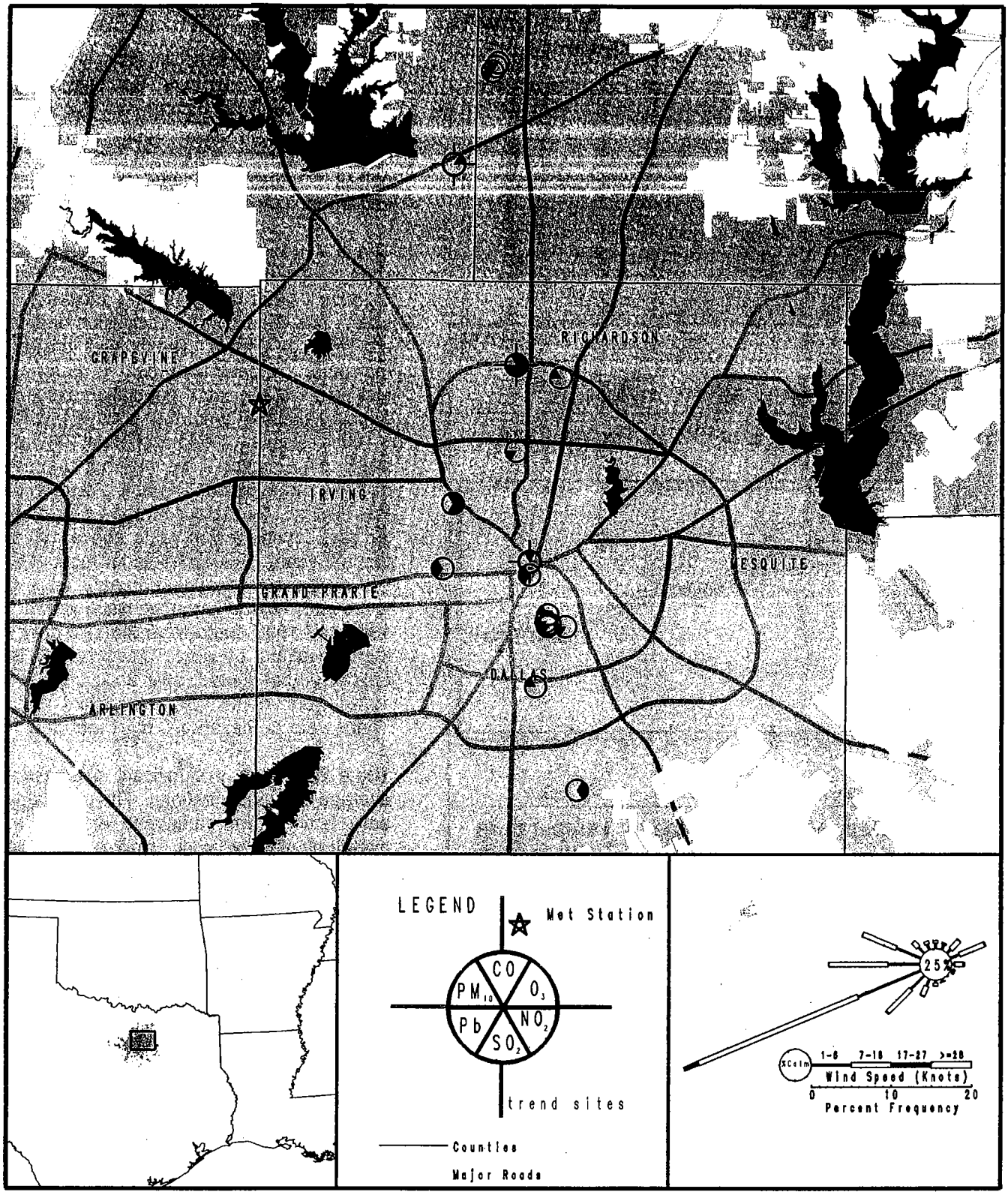
Chicago, IL

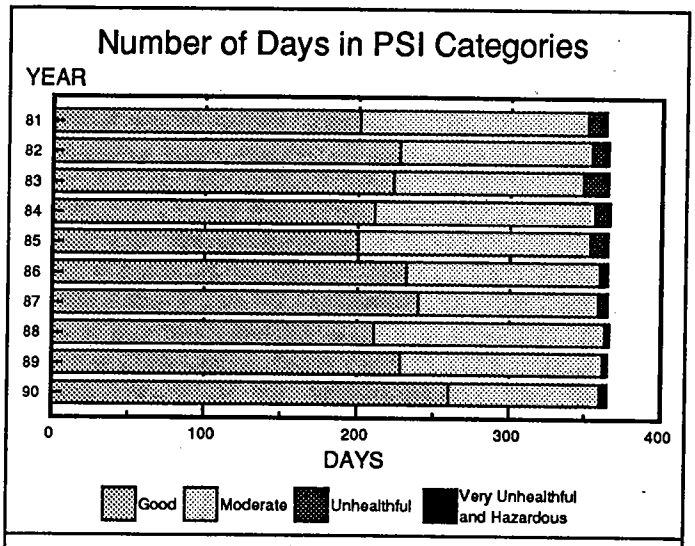
The Chicago PMSA consists of Cook, Du Page and McHenry Counties. The estimated 1987 population was 6.2 million with 85% living in Cook County. Its size and heavy industry contribute to the area's air pollution potential. There are 42 currently active monitoring sites located on the map.

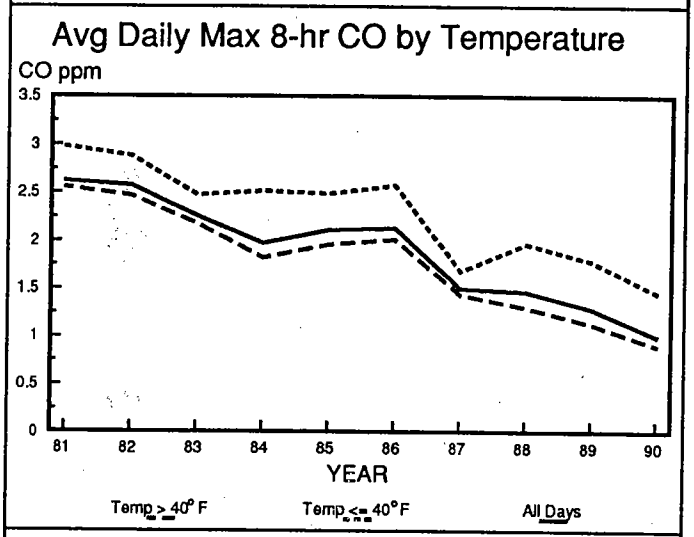
The PSI trend for Chicago is based on 6 sites: 2 sites that monitored for both CO and O_3, plus 1 other CO site and 3 additional O_3 sites. The CO sites are population oriented sites in Cook County. The O_3 sites include a maximum concentration site in northwest McHenry County and 4 population exposure oriented sites. The number of days with PSI > 100 is relatively stable except for 1983 and 1988. The impact of the very hot summers of 1983 and 1988 on O_3 levels is clear in the PSI display. Ozone accounted for 27 of the 32 days having a PSI value above 100 for these 2 years. CO accounts for most of the PSI days > 100 in the first 5 years, while O_3 is the main contributor in the last 5 years. In 1989 and 1990, there were 2 and 3 days in the unhealthful or worse category. In the entire 10-year period, only 2 days (both in 1988) were in the very unhealthful range. There were no hazardous days reported.

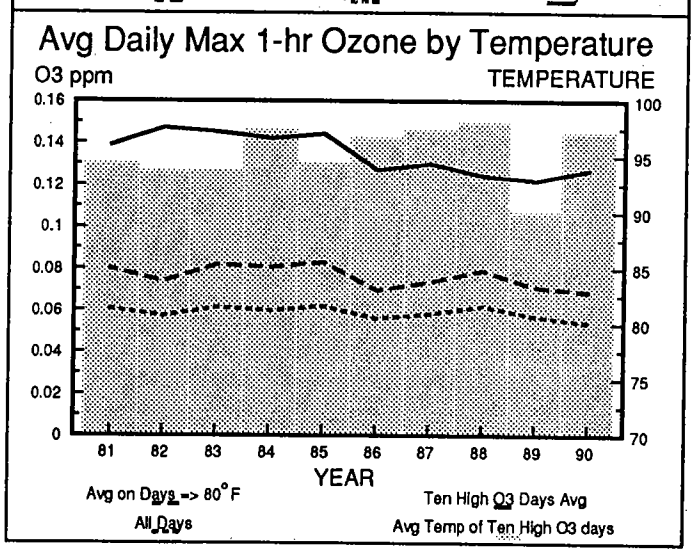
There has been a significant decrease in average CO concentrations. This occurred in both temperature categories and for the overall average as well. Unlike most cities CO levels are higher on the warmer days, averaging 16% higher.

Average O_3 levels do not show a significant long-term trend for any of the categories. The impact of the very hot 1983 and 1988 summers can be seen in the O_3 averages. The 1990 O_3 averages are the lowest reported over the ten year period. Average daily maximum temperature and O_3 are correlated significantly for the ten highest O_3 days.


GRAPEVINE
RICHARDSON
IRVING
GRAND PRAIRIE
DALLAS
MESQUITE
ARLINGTON
LEGEND
Met Station
CO
O_3
PM_{10}
Pb
NO_2
SO_2
trend sites
Counties
Major Roads
25%
Calm
1-6
7-18
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency







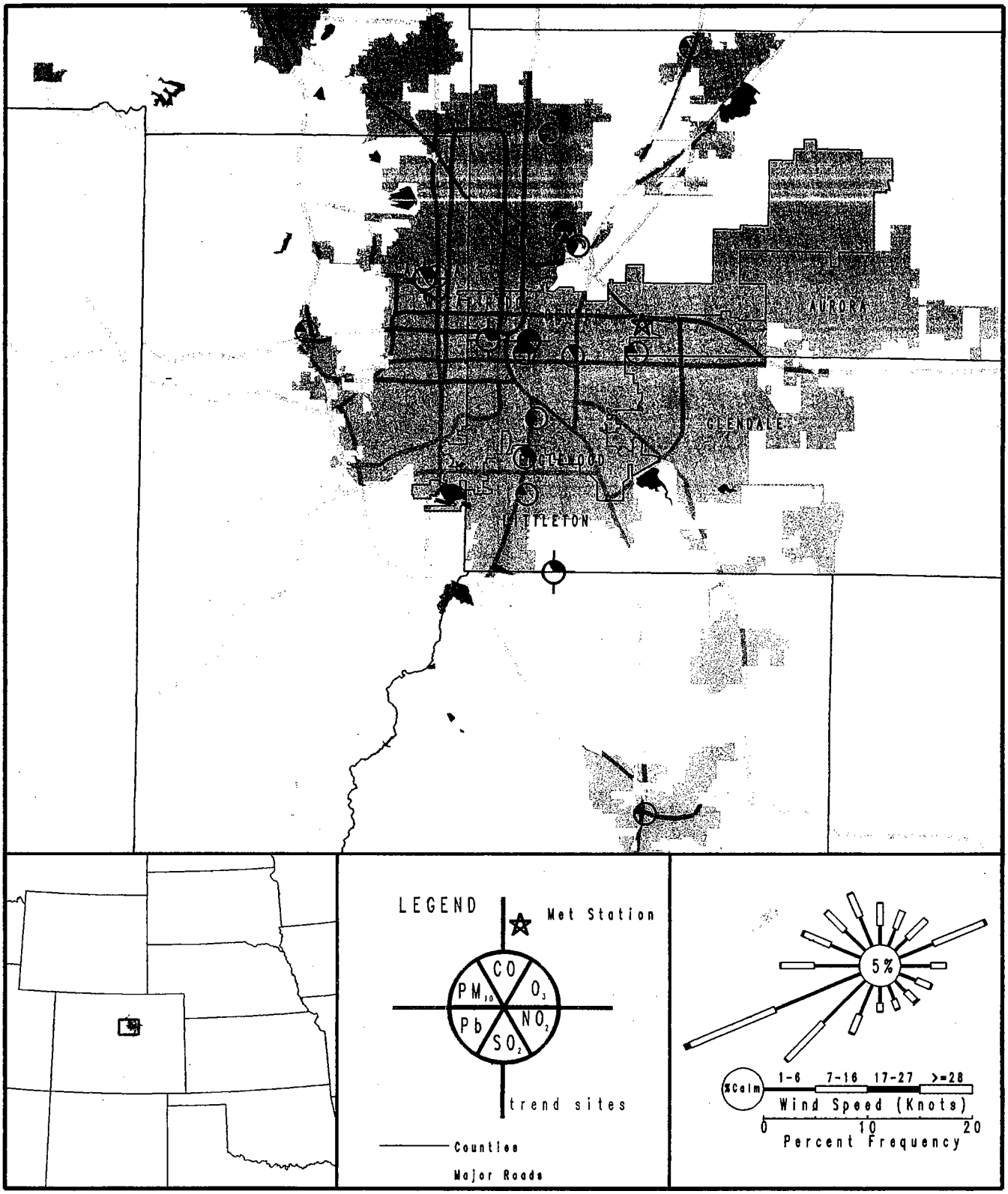
Dallas, TX

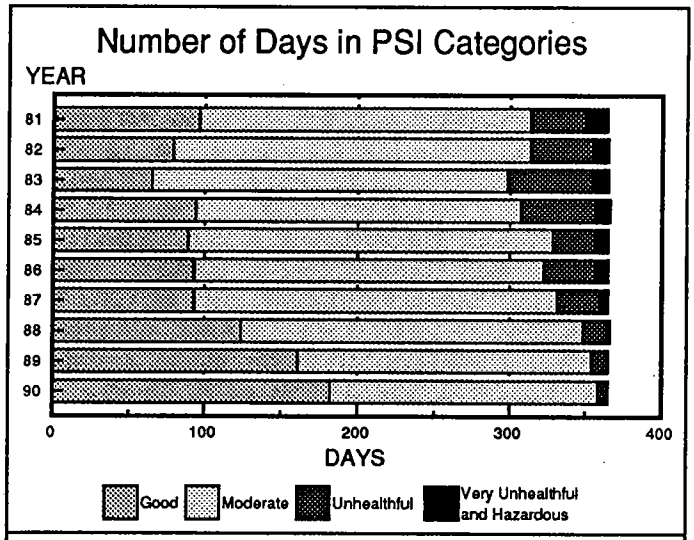
The Dallas PMSA consists of 6 counties with 75 percent of the population living in Dallas County. The estimated 1987 population was 2.5 million. Its size and summertime meteorology contribute to the area's air pollution potential. The map shows 19 currently active monitoring sites for the area.

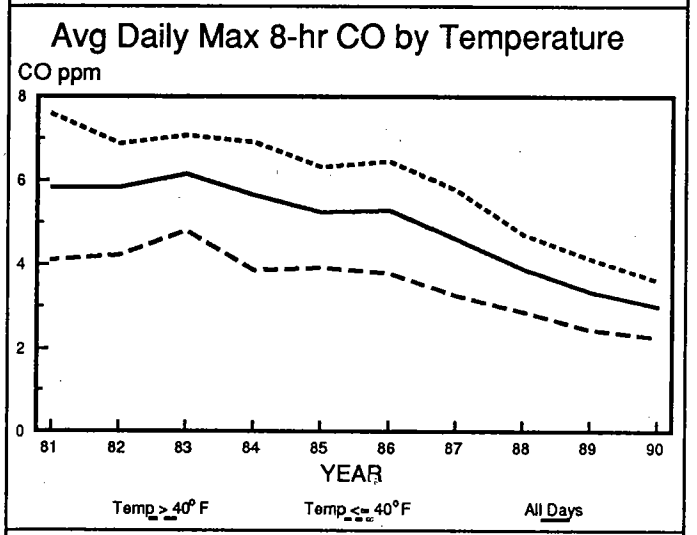
The PSI trend for Dallas is based on 3 sites: 1 for CO and 2 for O_3. The CO site is a maximum concentration site located in Dallas County. The O_3 sites are a maximum concentration site in Denton County and a population exposure oriented site in Dallas County. The number of PSI>100 days have declined over the 10-year period. This trend was significant. The number of these days averaged 12.4 in 1981-85 and 4.4 in 1986-90. In Dallas, all but 1 of the PSI>100 days are due to O_3. As expected most (77%) of these days occurred in the summer (June - August). The fall months (September - November) accounted for most of the rest of these days (15%). In 1990 there were 5 days above a PSI of 100. In the entire 10-year period only 1 day (in 1982) was in the very unhealthful range. There were no hazardous days reported.

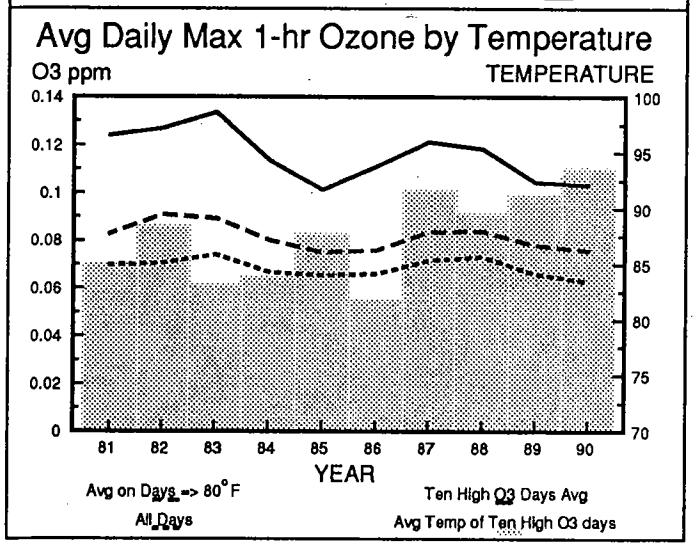
Average CO levels have decreased in both temperature categories and for the combined days. The trend was significant in all three cases. Average CO levels are 29% higher on the colder days.

There has also been a significant decline in average O_3 levels on the ten highest days. However, this amounted to only a 9% decline in average O_3 levels on the ten highest O_3 days over the 10-year period. The other O_3 categories did not show significant trends. The correlation between the average daily maximum temperature and O_3 levels on the ten highest O_3 days was not significant.


AURORA
GLENDALE
LITTLETON
LEGEND
Met Station
CO
O3
NO2
SO2
Pb
PM10
trend sites
Counties
Major Roads
5%
%Calm
1-6
7-16
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency







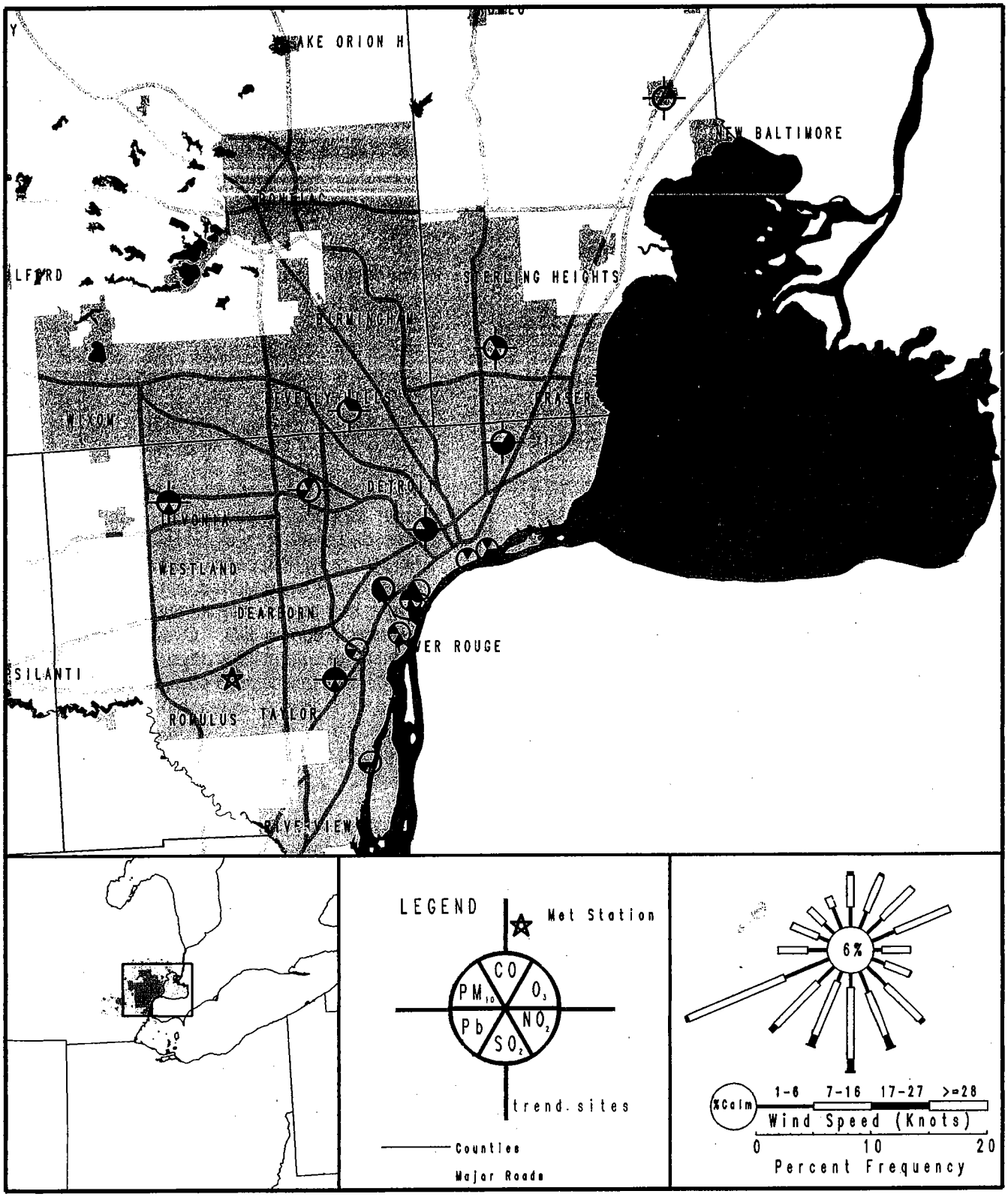
Denver, CO

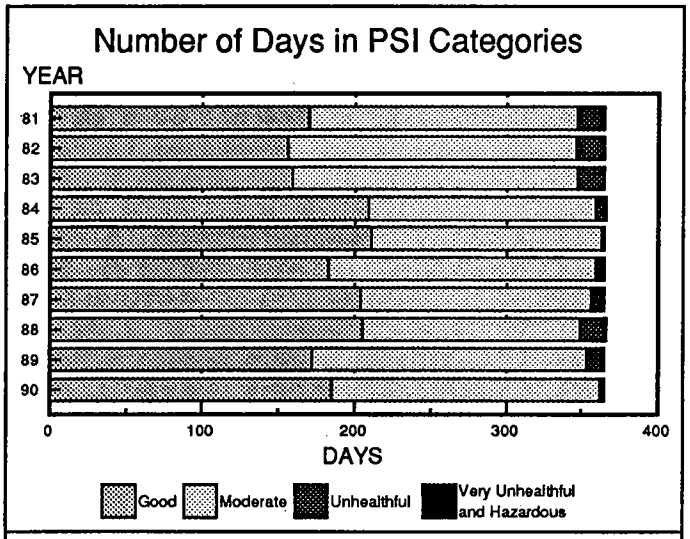
The Denver PMSA consists of 5 counties; Denver is the most populated with 30 percent of the area's 1.6 million residents, based upon estimates for 1987. The area's size and altitude contribute to its air pollution potential. Seventeen monitoring sites are currently active and are shown on the area map.

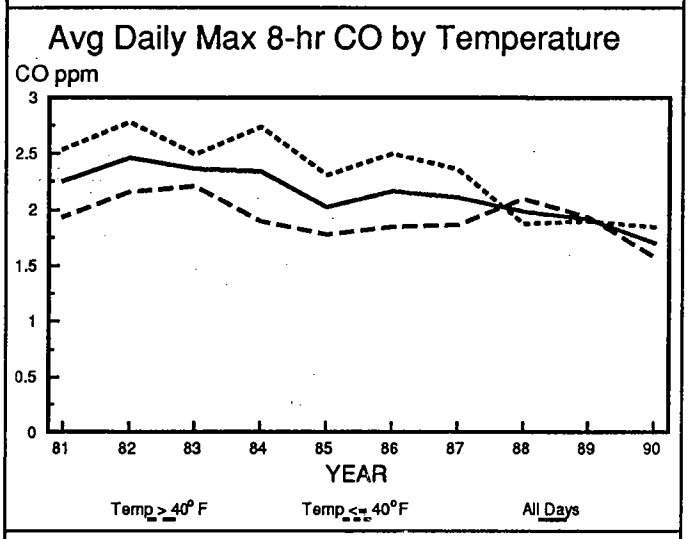
The PSI trend for Denver is based on 4 sites: 2 where both CO and O_3 are monitored plus 2 other CO sites. The CO sites are a maximum concentration site located in downtown Denver and 3 population oriented sites in Arapahoe, Denver and Jefferson Counties. The O_3 sites are a maximum concentration site in Arapahoe Co. and a population exposure site in Jefferson Co. The number of unhealthful or worse days have dropped, especially in recent years. This decrease was significant. Ninety-two percent of the PSI days>100 were due to CO and most (90%) occurred in the fall or winter. There has been a significant decline in the days>100 due to CO. Overall, the lowest number of unhealthful days (7) occurred in 1990. For the second straight year (1990), there were no very unhealthful days reported. Three days in the 10-year period were judged to be hazardous, the last occurring in 1985.

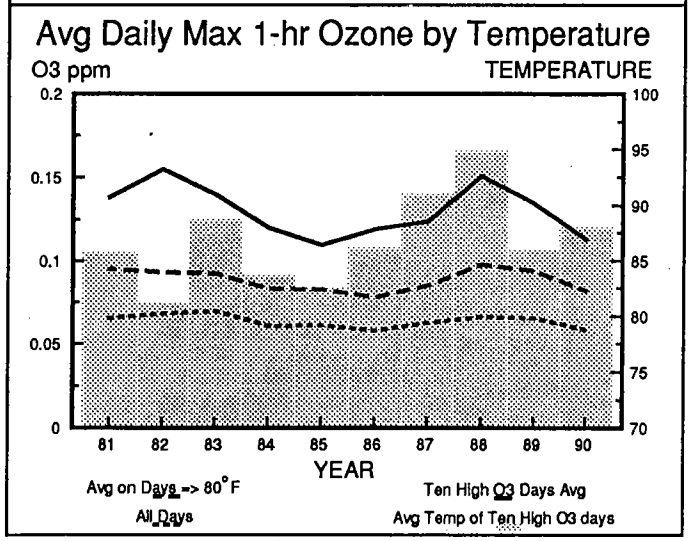
Average CO levels have declined significantly for both temperature categories and for all days. Average CO levels are 61% higher on the colder days.

Average O_3 levels have declined significantly on the ten highest O_3 days but not for the other averages. The O_3 averages on the ten highest days ranged from a low of 0.10 ppm in 1985, 1987 and 1990 to a high of 0.13 ppm in 1983. The trend in the ten highest O_3 days is down despite the average temperature being higher in the 1987-90 period. Average daily maximum temperature and O_3 levels on the ten highest days were not correlated significantly.


LAKE ORION H
NEW BALTIMORE
STERLING HEIGHTS
LFORD
WIXOM
WESTLAND
DEARBORN
ER ROUGE
SILANTI
ROMULUS
TAYLOR
LEGEND
Met Station
CO
O3
PM10
NO2
Pb
SO2
trend.sites
Counties
Major Roads
6%
Calm
1-6
7-16
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency





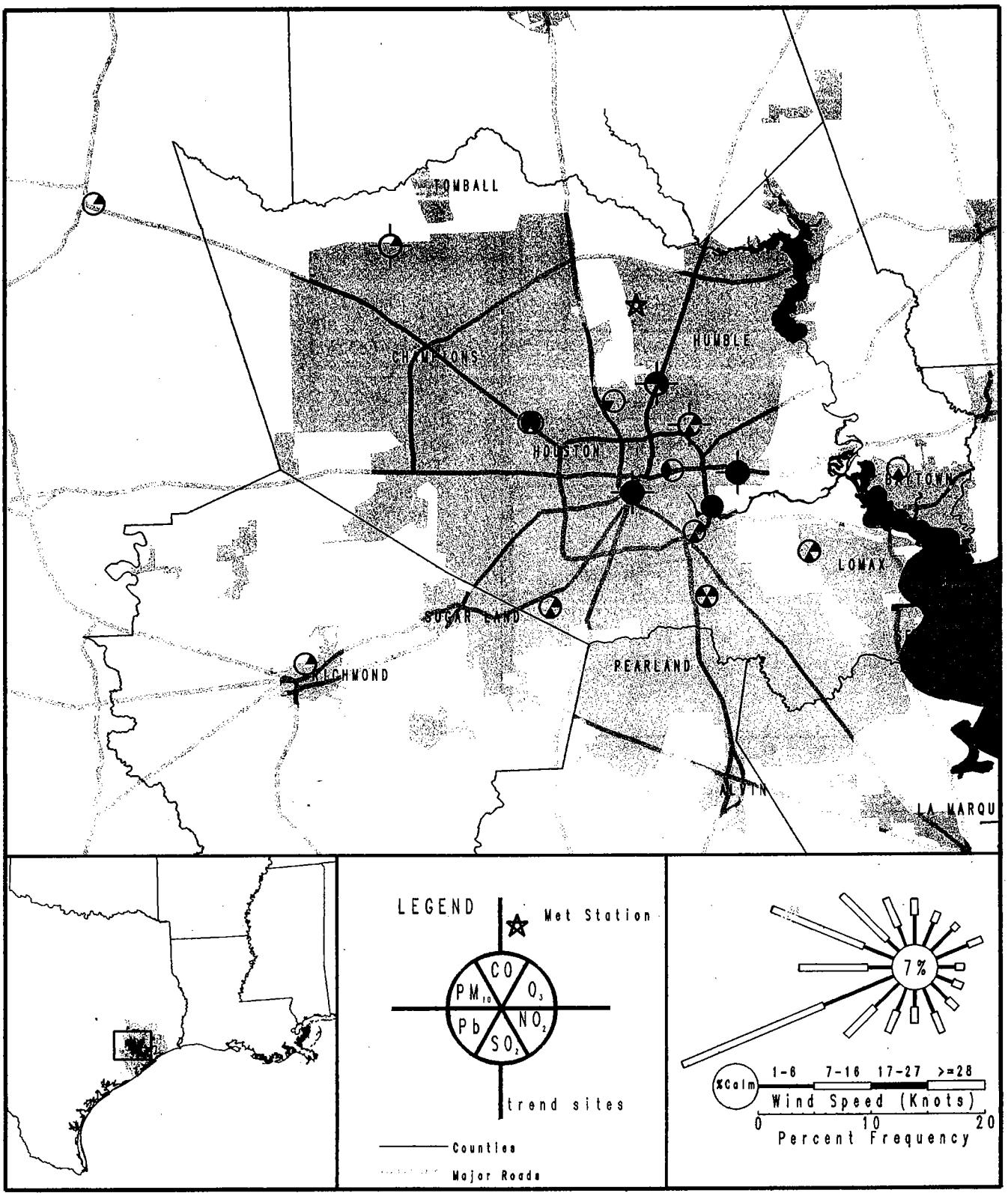


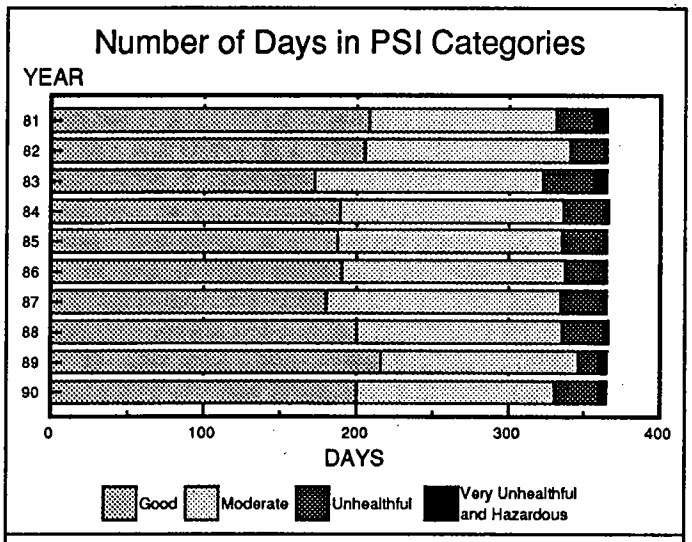
Detroit, MI

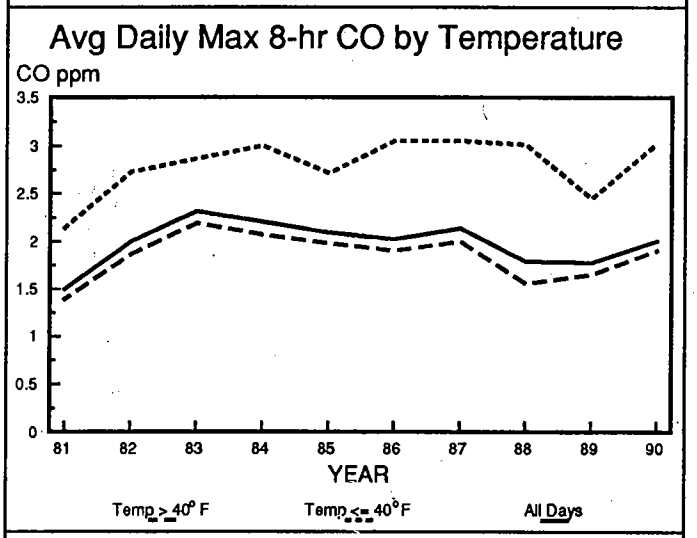
The Detroit PMSA consists of 7 counties with 73% of the population living in Wayne and Oakland counties. The estimated 1987 population was 4.4 million. It's size and industry contribute to the area's air pollution potential. A total of 21 monitoring sites are currently active in the PMSA - 18 of these sites are located in that portion of the PMSA shown on the map.

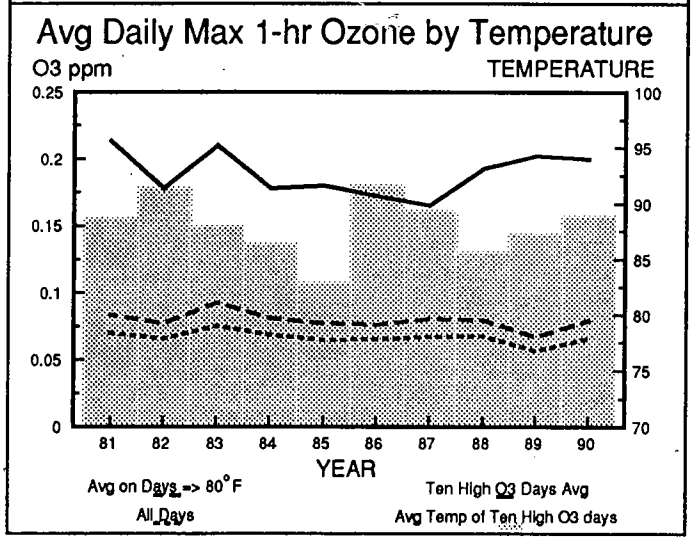
The PSI trend is based on 5 sites where both CO and O_3 are monitored, plus 1 additional site for CO and 3 other sites for O_3. Four of the CO sites are located in Wayne County, while Macomb and Oakland Counties each have 1 site. All of these CO sites are identified as population exposure oriented. There are 2 maximum concentration oriented O_3 sites among the trend sites - 1 each in Macomb and Wayne Counties. The number of PSI days greater than 100 were highest in 1981, 1982, 1983, 1988 and 1989 - averaging 17 days for these years. The lowest number of these days (2) occurred in 1985; while, the second lowest (3) occurred in 1990. There was not a significant trend in these PSI days. Eighty percent of these days occurred in the summer and fall. Seventy-nine percent of these days over the 10-year period were due to O_3. The only very unhealthful day occurred in 1988. There were no hazardous days reported.

Average CO levels showed a significant decline in the lower temperature category and for all days. Average CO levels are higher (21%) on the colder days. Average O_3 levels did not show a significant trend for the three averages presented. The average daily maximum temperature on the ten highest O_3 days was highest in 1988 (95° F) and lowest in 1982 (81° F). These two years had the highest average O_3 levels on the ten highest days. In 1982, the highest average O_3 was associated with the lowest average daily maximum temperature. Average daily maximum temperature and O_3 levels on the ten highest O_3 days were not significantly correlated.


TOMBALL
HUMBLE
HOUSTON
LOMAX
SUGAR LAND
REARLAND
LA MARQU
LEGEND
Met Station
CO
O3
PM10
NO2
Pb
SO2
trend sites
Counties
Major Roads
7%
Calm
1-6
7-16
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency







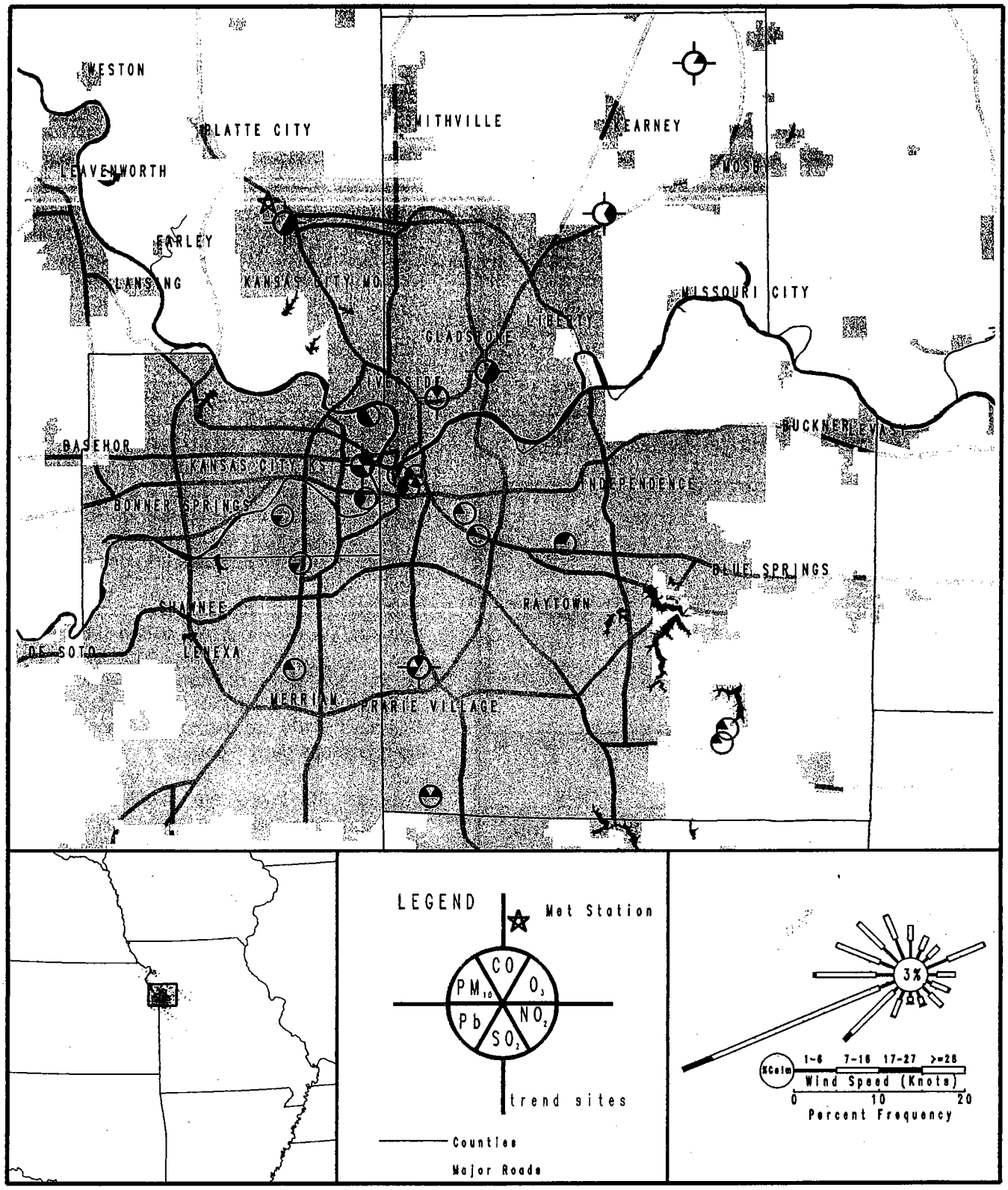
Houston, TX

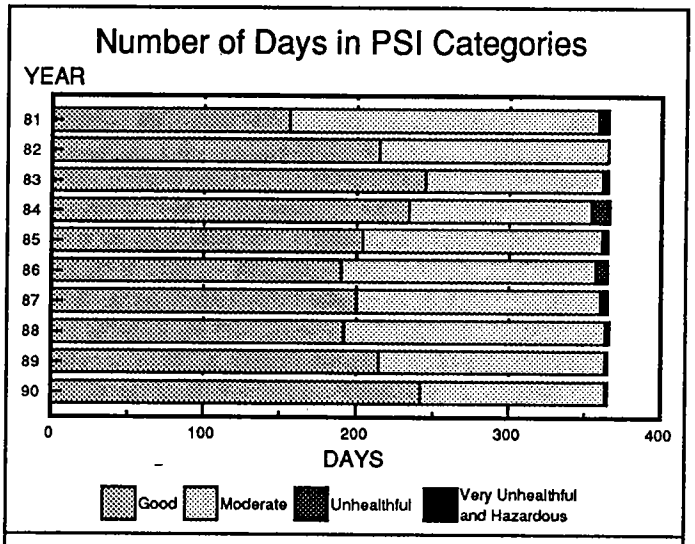
The Houston PMSA consists of the principal county of Harris and 4 other counties. The estimated 1987 population was 3.2 million with 86 percent living in Harris County. Its size and industry, mainly petroleum refineries, contribute to the area's air pollution potential. Its high temperatures and proximity to the Texas City-Galveston area are also factors which contribute to its air pollution potential. There are 17 currently active monitoring sites located on the map.

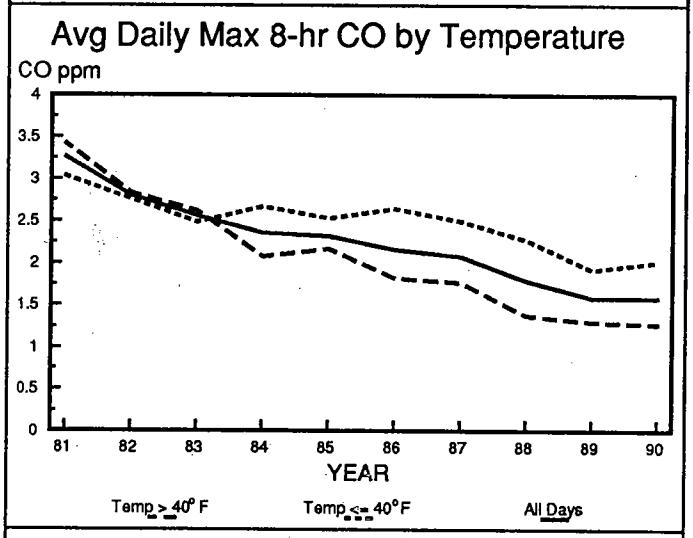
The PSI trend for Houston is based on 5 sites: 2 sites where both CO and O_3 were monitored, 1 additional site for CO and 2 additional sites for O_3. All of these sites are located in Harris County and include a maximum concentration site for each of these pollutants. The other sites are population exposure oriented. The number of PSI days > 100 is stable over the period. The lowest number of unhealthful days (19) occurred in 1989; while, the highest (43) occurred in 1983. The very unhealthful days range from a low of 0 in 1987 to a high of 8 in 1981 and 1983. During the 10-year period, 37 (12%) of the 306 days of PSI>100 were very unhealthful. In Houston, 97 percent of the PSI days > 100 are due to O_3. There were no hazardous days reported.

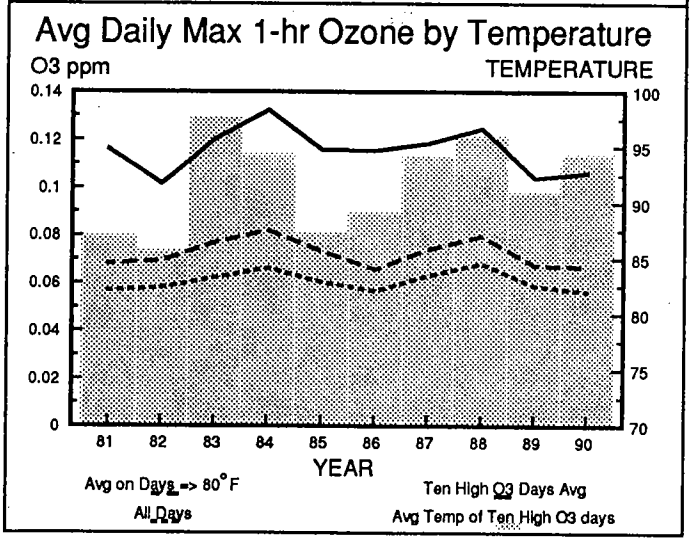
Average CO levels are stable over the 10-year period and do not show a significant trend. The 10 year CO average on the days with a minimum temperature below 40° F was 51 percent higher than on the warmer days.

Average O_3 levels were also stable for all the O_3-temperature categories and did not show a statistically significant trend. The lowest average O_3 concentration (0.17 ppm) on the ten highest O_3 days occurred in 1987. Average daily maximum temperature on the ten highest O_3 days ranged from a low of 83° F in 1985 to a high of 92° F in 1986. Average daily maximum temperature and O_3 on the ten highest days were not significantly correlated.


WESTON
PLATTE CITY
SMITHVILLE
KEARNEY
LEAVENWORTH
EARLEY
LANSING
KANSAS CITY, MO.
MISSOURI CITY
GLADSTONE
LIBERTY
RIVERSIDE
BUCKNER
BASEHOR
KANSAS CITY, KS.
INDEPENDENCE
BONNER SPRINGS
BLUE SPRINGS
RAYTOWN
SHAWNEE
DE SOTO
LENEXA
MERRIAM
PRAIRIE VILLAGE
LEGEND
Met Station
CO
O3
PM10
NO2
Pb
SO2
trend sites
Counties
Major Roads
3%
Scale
1-6
7-16
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency







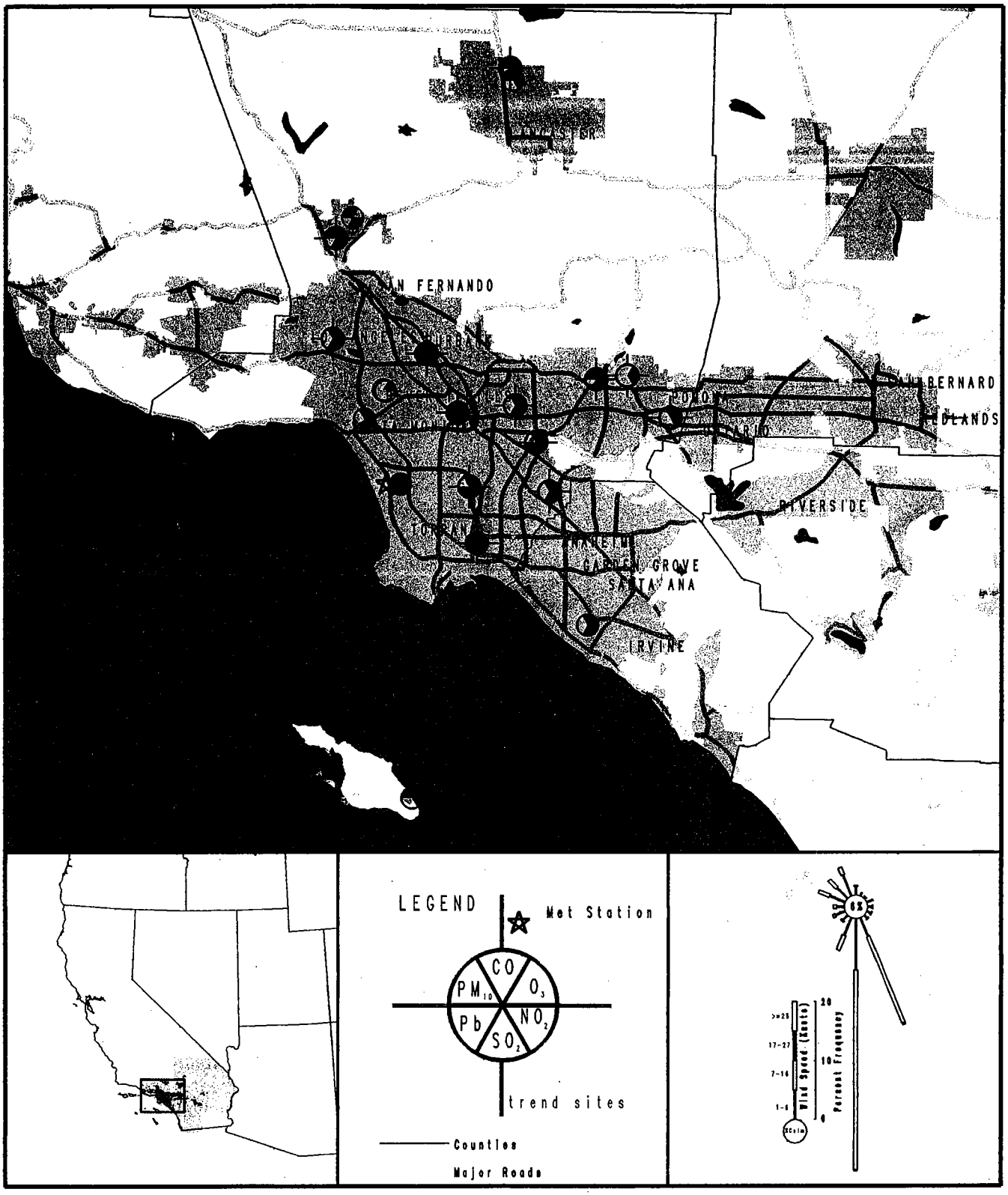
Kansas City, MO-KS

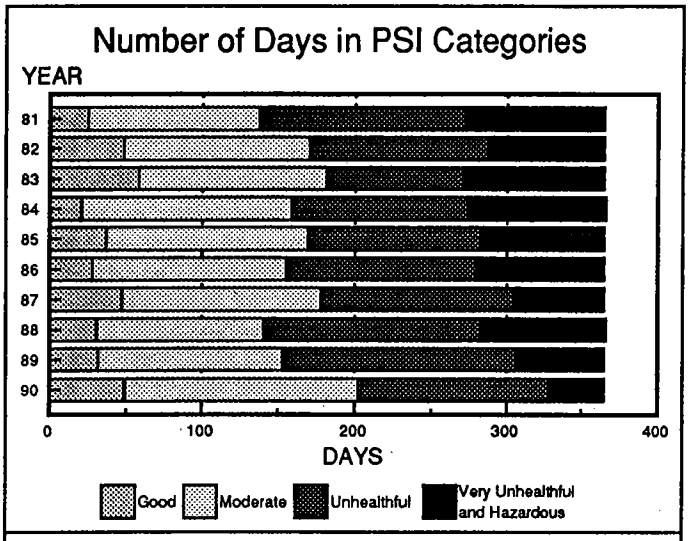
The Kansas City MSA consists of 6 counties in Missouri and 4 counties in Kansas. The estimated 1987 population was 1.5 million. Its size and summertime meteorology contribute to the area's air pollution potential. Its chief air quality problems occur during the summer when the hot, stagnant days are conducive to O_3 formation. The map shows 21 currently active monitoring sites in this PMSA.

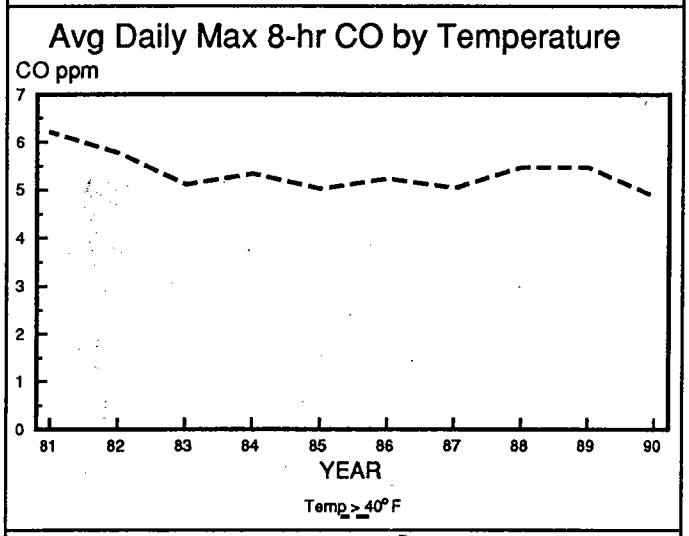
The PSI trend for Kansas City is based on 7 monitoring sites: 1 site where both CO and O_3 are monitored plus 2 other CO and 4 other O_3 sites. These CO sites are all population exposure oriented, while the O_3 sites include 1 maximum concentration site and 4 population exposure sites. The largest number(12) of unhealthful days occurred in 1984. The last 2 years had 2 unhealthful days each. O_3 accounted for 33 (70%) of the 47 unhealthful days during the 10-year period. There were 9 unhealthful days attributed to PM-10 - the last occurred in 1989. Sixty-four percent of these days occurred during the summer (June-August). There is a significant downward trend in the number of these days. In the 10-year period there were no days in the very unhealthful or worse ranges.

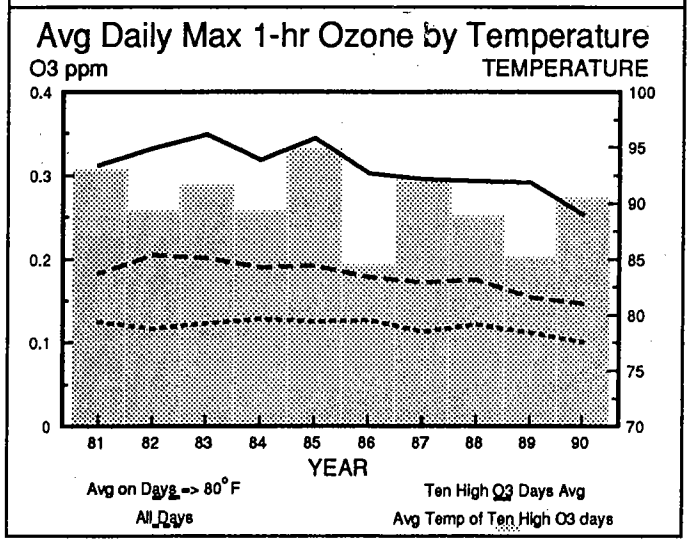
Average CO levels have dropped significantly over the 10-year period in both temperature categories and overall. CO levels are higher on the colder days especially in the latter half of the period.

Average O_3 levels show no clear long-term trend over the 10-year period for all temperature categories. Average daily maximum temperature on the ten highest O_3 days varied from a low of 86° F in 1982 to a high of 98° F in 1983. Visually the average daily maximum temperature and O_3 on the ten highest days appear to track together. This was confirmed when these variables had a significant positive correlation.


SAN FERNANDO
RIVERSIDE
ANAHEIM
GARDEN GROVE
SANTA ANA
IRVINE
LEGEND
Met Station
CO
O3
NO2
SO2
Pb
PM10
trend sites
Counties
Major Roads
Wind Speed (knots)
Percent Frequency







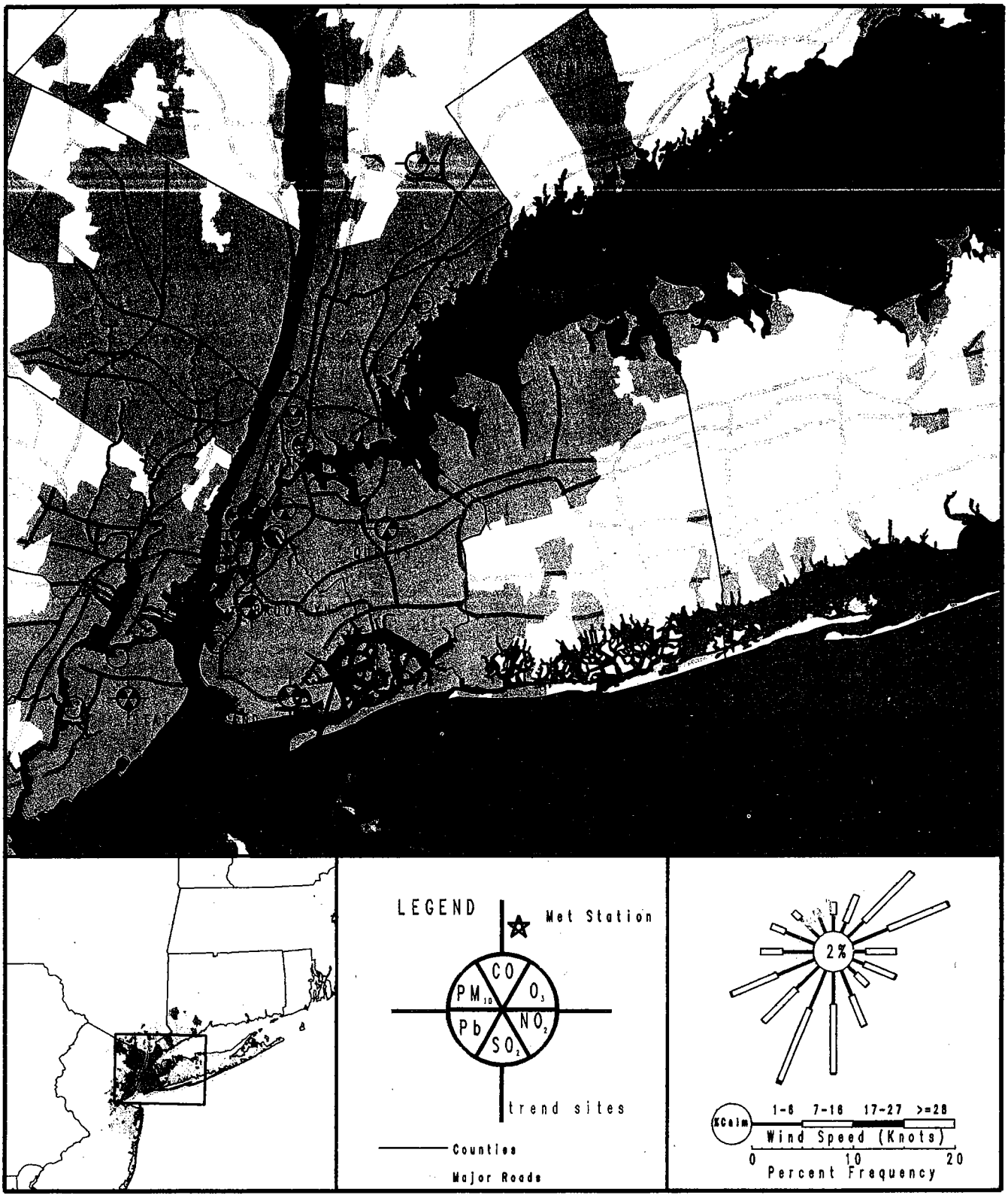
Los Angeles, CA

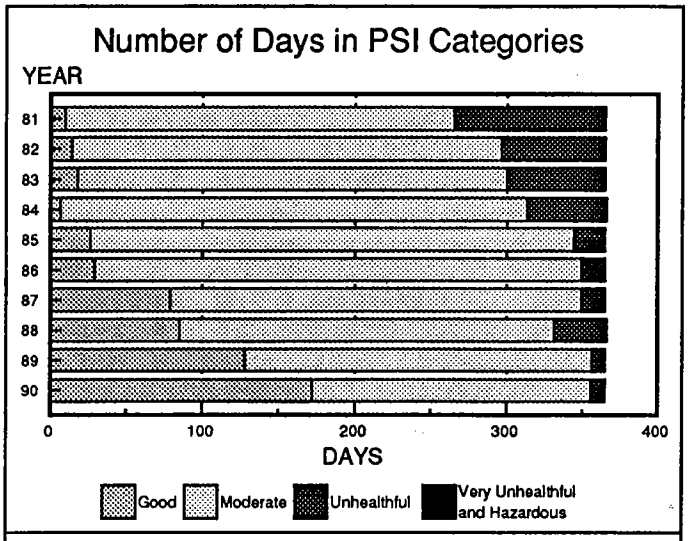
The Los Angeles PMSA consists of Los Angeles County, where an estimated 8.5 million people lived in 1987. The Los Angeles "basin" is bounded by the Pacific Ocean on the west and south and several mountain ranges on the north and east. Its complex meteorology is characterized by a land-sea-breeze circulation, frequent inversions and a high incidence of sunlight. There are 21 currently active monitoring sites located on the map.

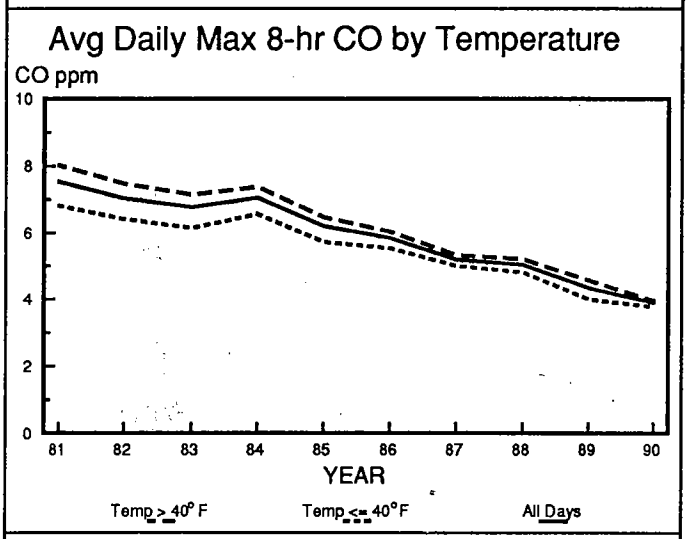
The PSI trend for Los Angeles is based on 13 sites: 11 where both CO and O_3 are monitored plus 2 other O_3 sites. For each pollutant, there is a NAMS maximum concentration site; the others are all population oriented SLAMS sites. Los Angeles has the largest number of PSI days > 100 of any urban area - averaging 201 per year for the 10-year period. The trend in these days is essentially flat; however, there has been a 60 percent reduction in the very unhealthful days over the 10-year period. The number (37) of very unhealthful days in 1990 was the lowest reported for the 10-year period. The smallest number (163) of days with a PSI > 100 occurred in 1990. In 1990, these 163 days were broken down into 126 unhealthful and 37 very unhealthful days. In the Los Angeles PMSA, 73 percent of the PSI days > 100 are due to O_3. In the 10-year period, only 1 day (1982) was in the hazardous category.

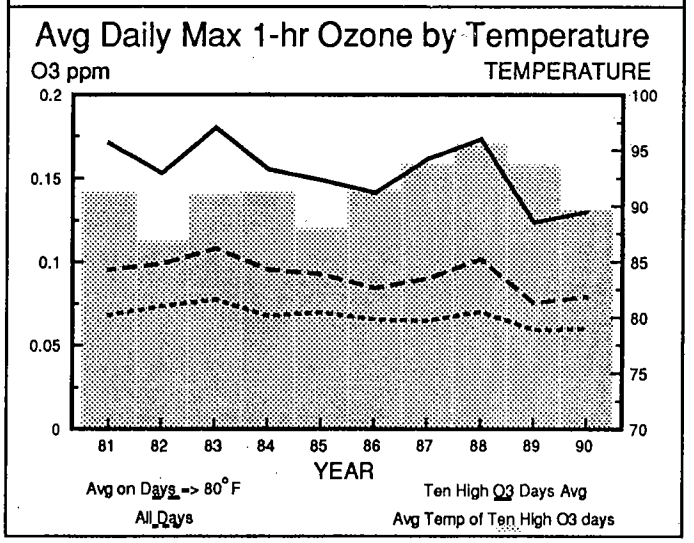
There is a significant downward trend in average CO levels on all days. There were insufficient days in the lower temperature category so the temperature category averages are omitted.

Average O_3 levels showed a significant downward trend over the period for the ten highest O_3 days and for days with temperatures of 80° F or above. The lowest O_3 average occurred in 1990 for both the ten highest O_3 days and for all days. The temperature data were taken at the Los Angeles Civic Center in downtown LA.


LEGEND
Met Station
CO
O_3
PM_{10}
NO_2
Pb
SO_2
trend sites
Counties
Major Roads
2%
Calm
1-6
7-16
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency





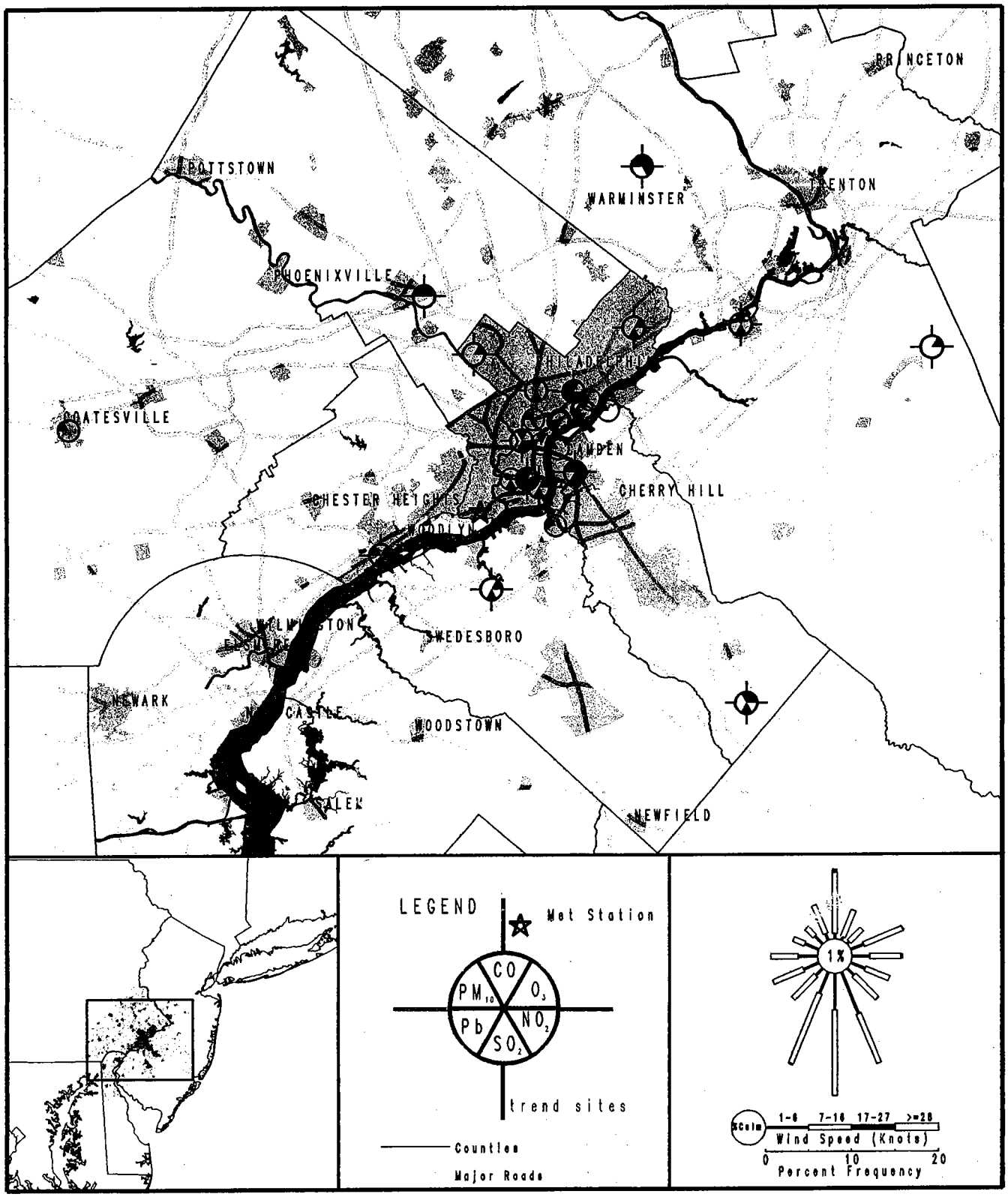


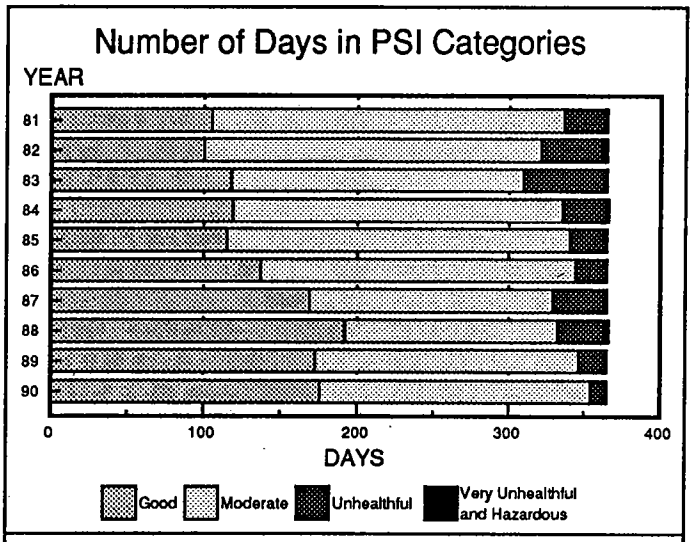
New York, NY

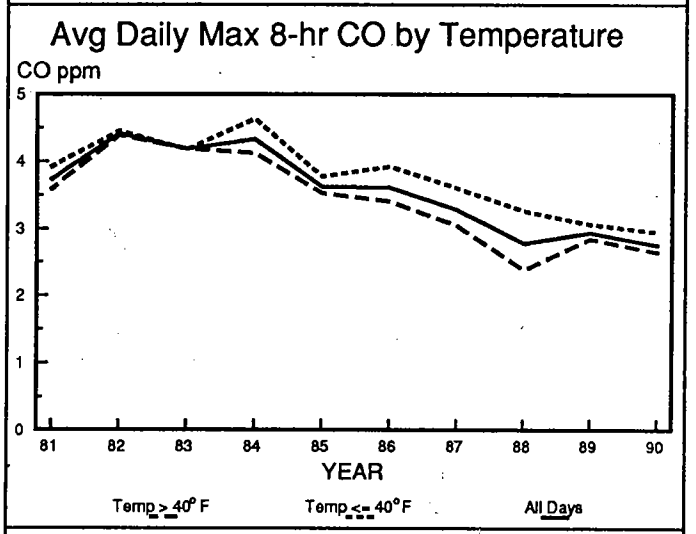
The New York PMSA consists of 8 counties with 81 percent of the 8.5 million population in Bronx, Kings, New York and Queens Counties. Its size and location as a part of the eastern seaboard megalopolis contribute to the area's air pollution potential. Twenty-four monitoring sites are operating in the PMSA - twenty-two of which are located in the portion of the PMSA shown on the map.

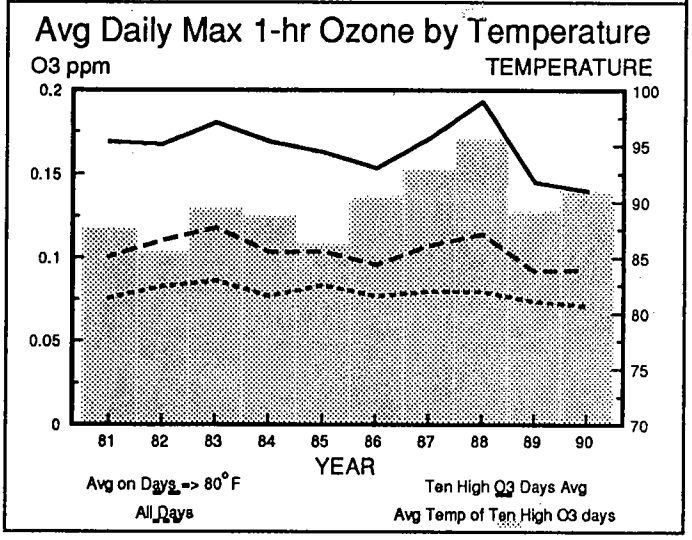
The PSI trend for New York is based on data from 8 sites: 3 for CO and 5 for O_3. The CO sites are 2 maximum concentration sites located in Manhattan (New York County) and a population exposure site in Kings County. The O_3 sites include a maximum concentration site in Westchester County. Unlike most areas, PSI days > 100 are due more to CO (58%) than O_3 over the 10-year period; however, O_3 has contributed more PSI > 100 days since 1987. In 1983 and particularly 1988 the impact of the very hot summers is seen with the increase in the number of these days due to O_3. The most dramatic improvement has been in CO where the number of these days declined from 79 in 1981 to 2 in 1990. The trend in the number of unhealthful or worse days was significant for all days and for days when CO was the responsible pollutant. There was a total of 9 very unhealthful days reported, but none in 1989 or 1990. No hazardous days were reported.

Average CO levels showed a significant drop over the period for both temperature categories and for all days. Unlike most of the other urban areas studied, CO levels are higher on the warmer days. The CO average on the warmer days was 12% higher. Average O_3 levels also decreased significantly for all days and for days with temperatures of 80° F or higher. Average daily maximum temperature for the ten highest O_3 days varied from a low of 87° F in 1982 to a high of 96° F in 1988. The correlation between average daily maximum temperature and O_3 on the ten highest O_3 days was low and not significant.


PRINCETON
POTTSTOWN
WARMINSTER
TRENTON
PHOENIXVILLE
PHILADELPHIA
CAMDEN
CHERRY HILL
CHESTER HEIGHTS
WOODLYN
WILMINGTON
SWEDESBORO
NEWARK
NEW CASTLE
WOODSTOWN
SALEM
NEWFIELD
LEGEND
Met Station
CO
O3
PM10
NO2
Pb
SO2
trend sites
Counties
Major Roads
1%
Calm
1-6
7-16
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency







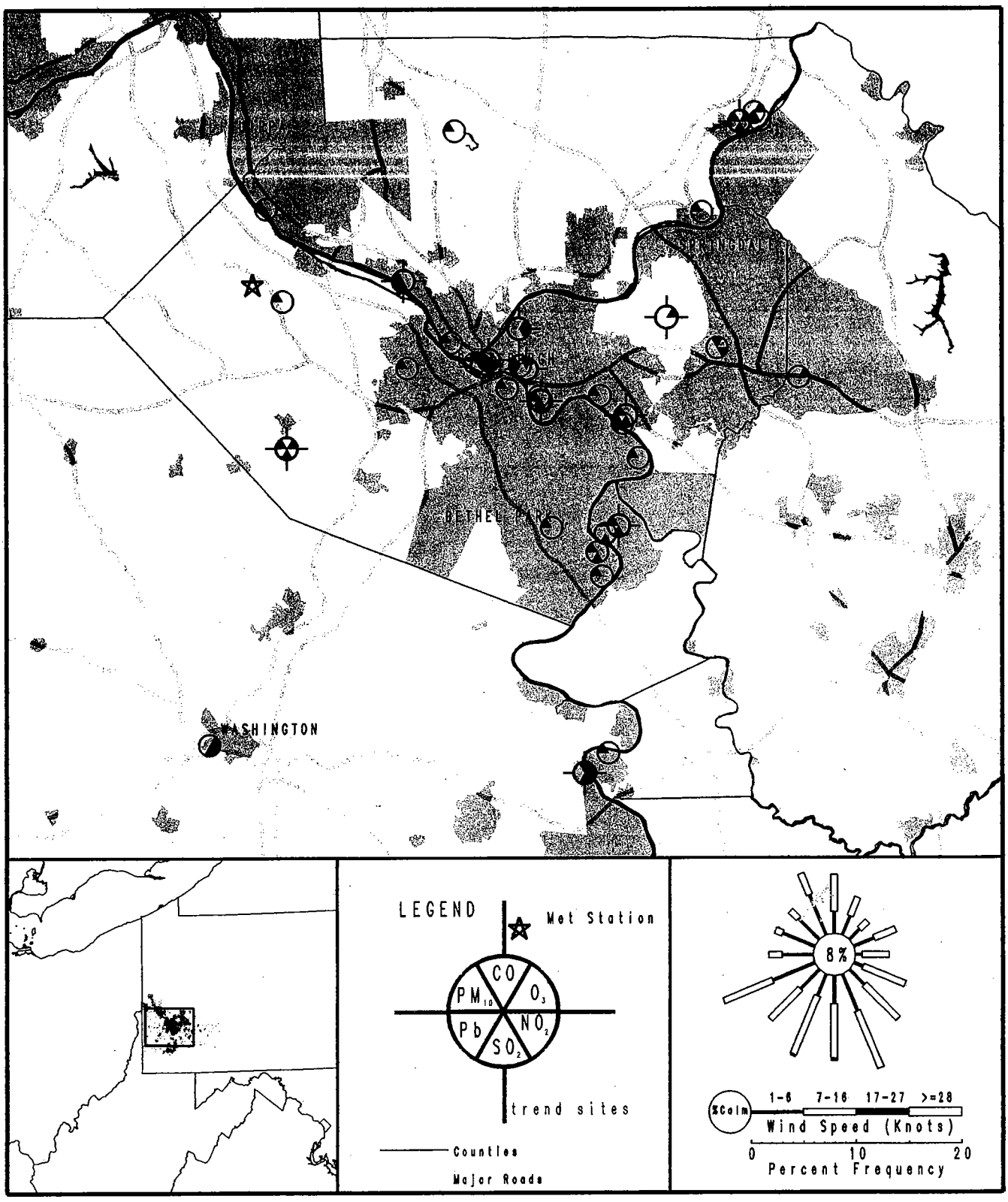
Philadelphia, PA

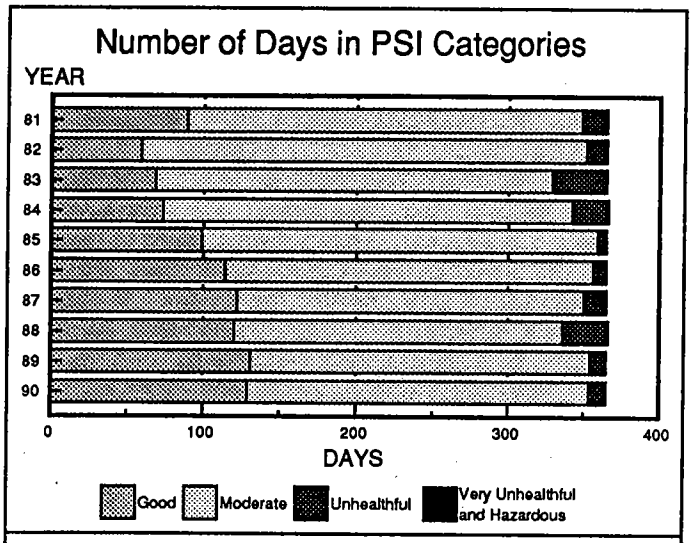
The Philadelphia PMSA consists of 8 counties, 5 in Pennsylvania and 3 in New Jersey. The most populated county is Philadelphia which accounts for 33 percent of the total population. The estimated 1987 population was 4.9 million. Its size and location as a part of the eastern megalopolis contribute to the area's air pollution potential. There are 29 currently active air monitoring sites shown on the map.

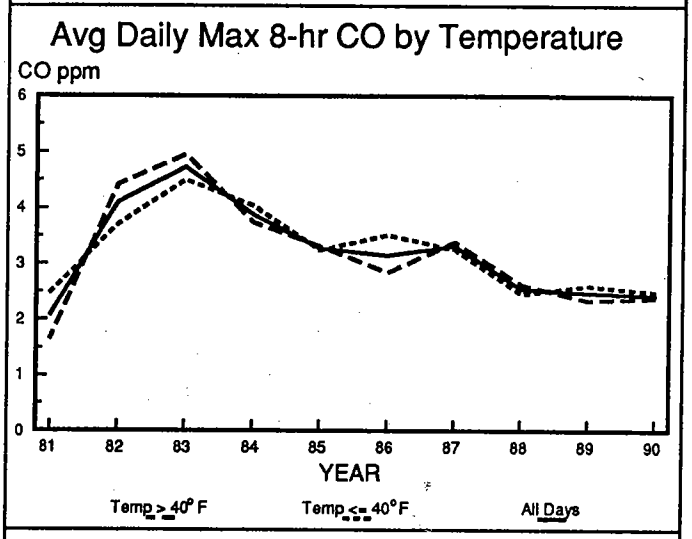
The PSI trend for Philadelphia is based on data from 15 sites: 4 sites where both CO and O_3 are monitored, 5 additional CO sites and another 6 O_3 sites. The CO sites include two maximum concentration sites located in Philadelphia and Burlington Co., New Jersey. The O_3 sites include maximum concentration sites in New Jersey for Burlington, Gloucester and Camden counties. The trend in the PSI days > 100 did not show a significant trend over the 10-year period but the number of these days declined in 1989-90. The total of 11 of these days in 1990 was the lowest reported. The next lowest was 19 in 1989. The number of unhealthful or worse days due to O_3 dropped from a high of 52 in 1983 to a low of 11 in 1990. Eighty-seven percent of the PSI days > 100 are due to O_3. In the 10 years, 12 days were in the very unhealthful range. No days in the hazardous range were reported.

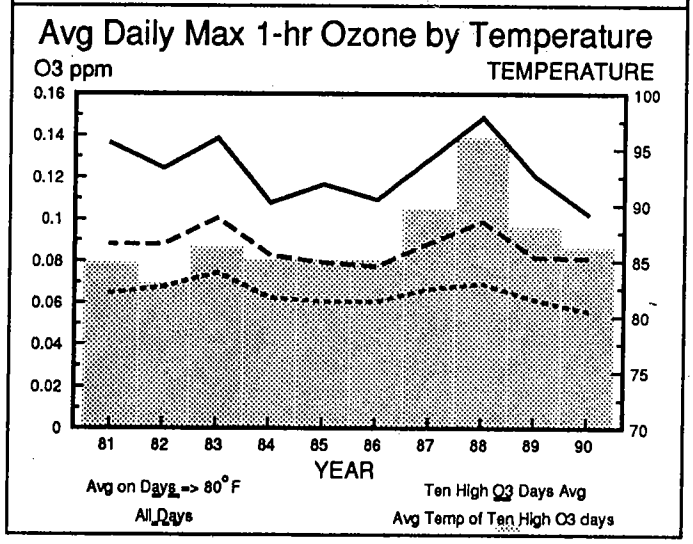
Average CO levels have declined significantly over the 10-year period in both temperature categories and for all days. CO levels are 11% higher on the colder days.

Average O_3 levels do not show a significant trend; although, for all three averages presented the two lowest averages occurred in 1989 and 1990. Average daily maximum temperature for the ten highest O_3 days ranged from a low of 85° F in 1982 to a high of 96° F in 1988. Average daily maximum temperature and O_3 levels on the ten highest O_3 days were not significantly correlated.


BETHEL PARK
WASHINGTON
LEGEND
Met Station
CO
O_3
NO_2
SO_2
Pb
PM_{10}
trend sites
Counties
Major Roads
8%
%Calm
1-6
7-16
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency







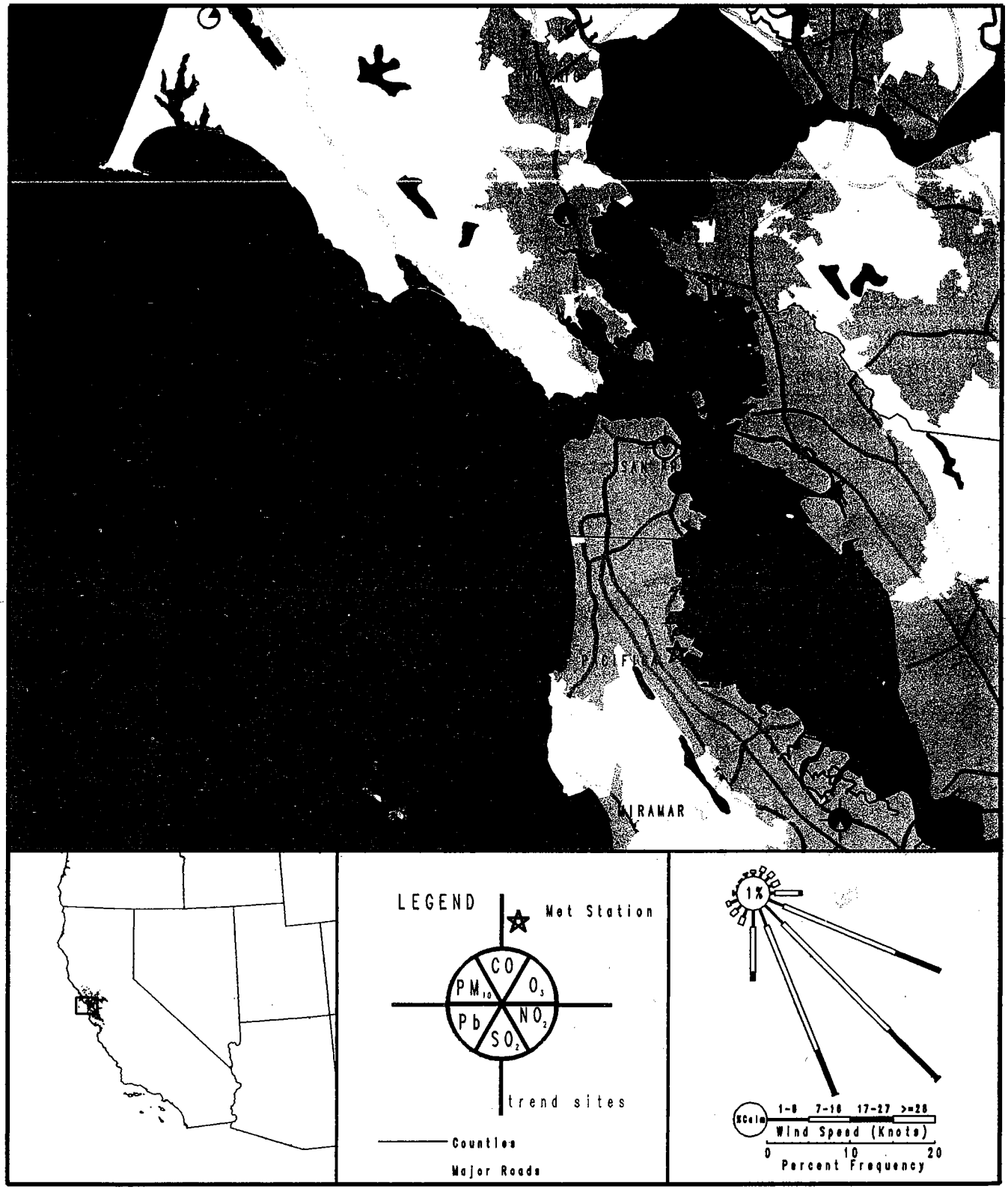
Pittsburgh, PA

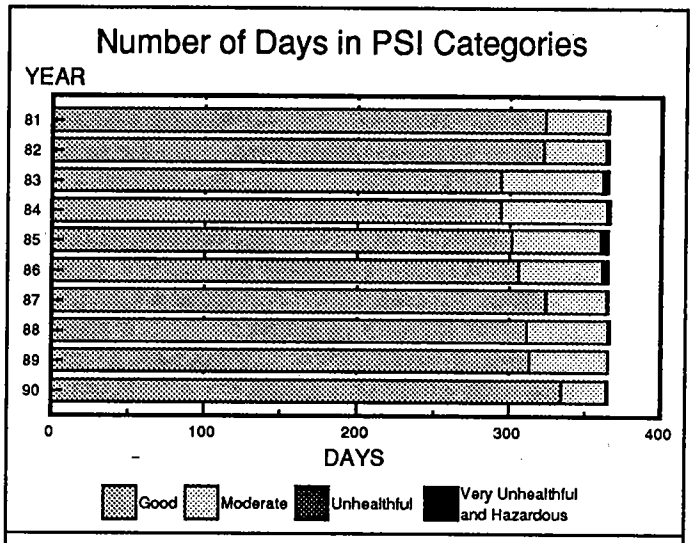
The Pittsburgh PMSA consists of 4 counties, with 65 percent of the population living in Allegheny County. The estimated 1987 population for the entire area was 2.1 million. Its size and heavy industry contribute to the area's air pollution potential. There are 36 currently active monitoring sites shown on the map.

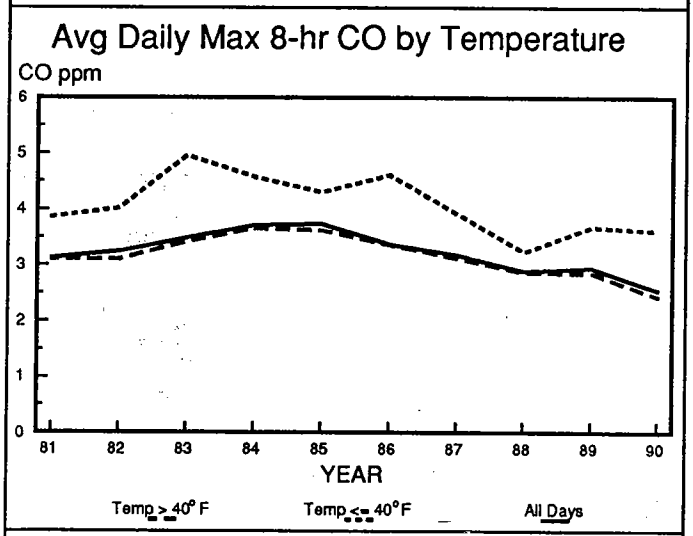
The PSI trend is based on data from 12 sites: 1 where CO, O_3 and SO_2 are all monitored, 3 where both O_3 and SO_2 are measured plus 8 other monitoring sites (2 CO, 1 O_3 and 5 SO_2). Each of these pollutants had a NAMS maximum concentration site in Allegheny County. The other sites were all population exposure oriented. The number of unhealthful or worse days varied from a low of 6 in 1985 to 36 in 1983. Ozone accounted for most of these days in 1988 when the meteorology was especially conducive for O_3 formation. A trend test was not significant on the number of these days over the 10 years. Thirty-seven percent of all PSI days > 100 are due each to O_3 and SO_2. The remainder of high PSI days are due to CO (14 percent) and PM-10 (12 percent). In the 10-year period, 2 days (the last in 1985) fell in the very unhealthful category. No hazardous days were reported.

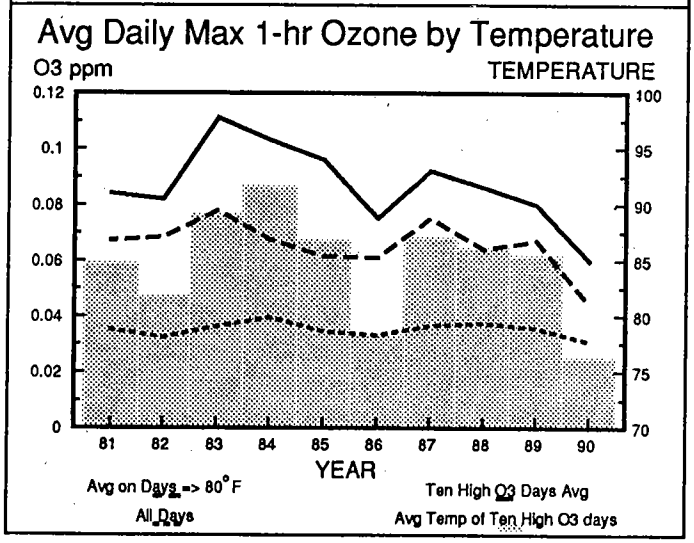
Average CO levels increased from 1981 to 1983 and then decreased but this mixed pattern resulted in no significant overall trend. Average CO levels are slightly higher on the warmer days.

Average O_3 levels show no clear long-term trend, with peaks occurring in 1983 and 1988. However, the lowest average for each O_3 category occurred in 1990. Average daily maximum temperature for the ten highest O_3 days varied from a low of 83° F in 1982 to 96° F in 1988. The correlation was not significant between the average daily maximum temperature and O_3 on these days.


MIRAMAR
LEGEND
Met Station
CO
O_3
NO_2
SO_2
Pb
PM_{10}
trend sites
Counties
Major Roads
1%
Calm
1-6
7-16
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency







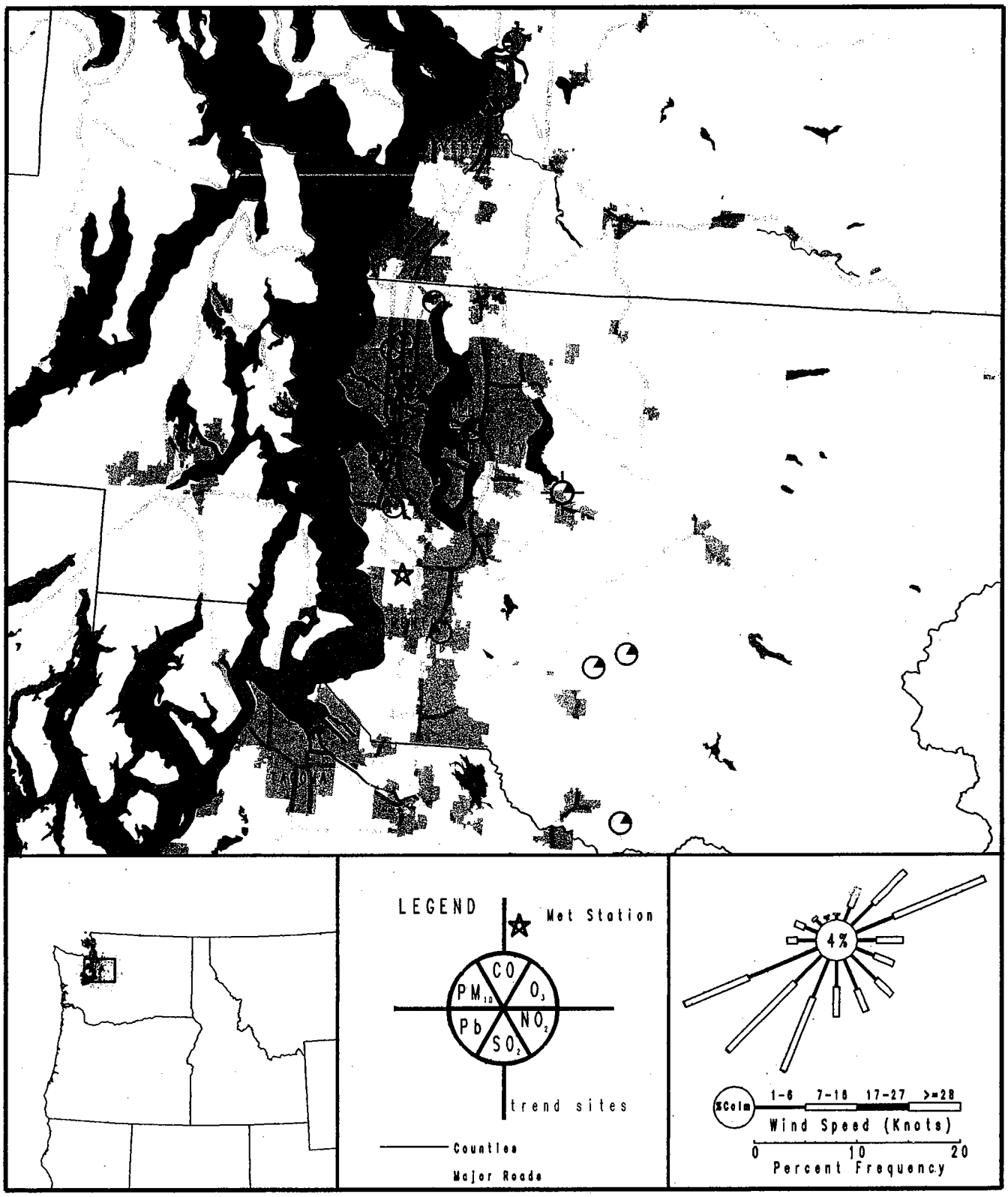
San Francisco, CA

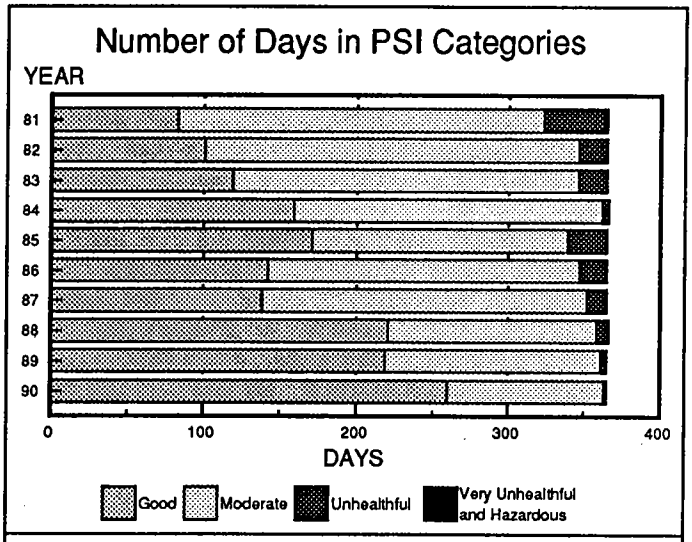
The San Francisco PMSA consists of Marin, San Francisco and San Mateo Counties. The estimated 1987 population was 1.6 million. Its urban area size contributes to the area's air pollution potential. There are 5 currently active monitoring sites located on the map.

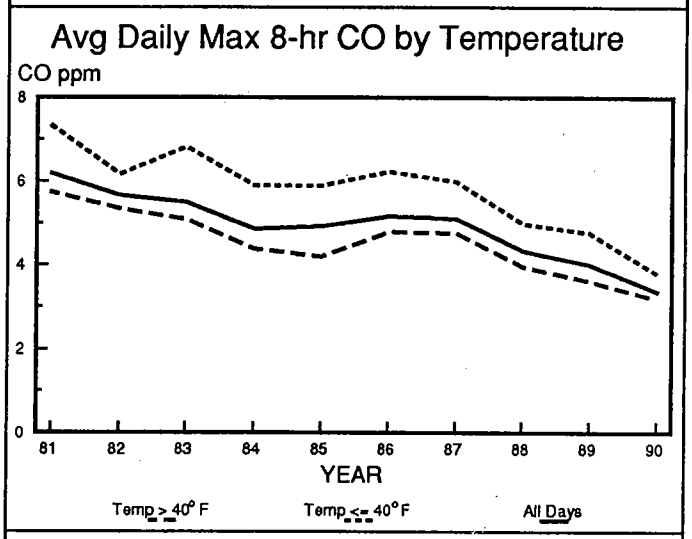
The PSI trend for San Francisco is based on data from 3 sites: 2 monitoring both CO and O_3 and additional one site for CO. The CO sites are a NAMS maximum concentration site located in San Francisco County and 2 population exposure sites in Marin and San Mateo Counties. The O_3 data are from 2 population exposure sites in Marin and San Mateo Counties. The number of PSI days > 100 average slightly more than 2 days per year. The largest number of these days (5) occurred in 1985. In 1990, there was one day reported. A trend test did not show a significant trend in these days over the 10-year period. In San Francisco, 76% of the PSI days > 100 are due to CO. In the entire 10-year period, only 1 day (in 1985) was in the very unhealthful range. No hazardous days were reported.

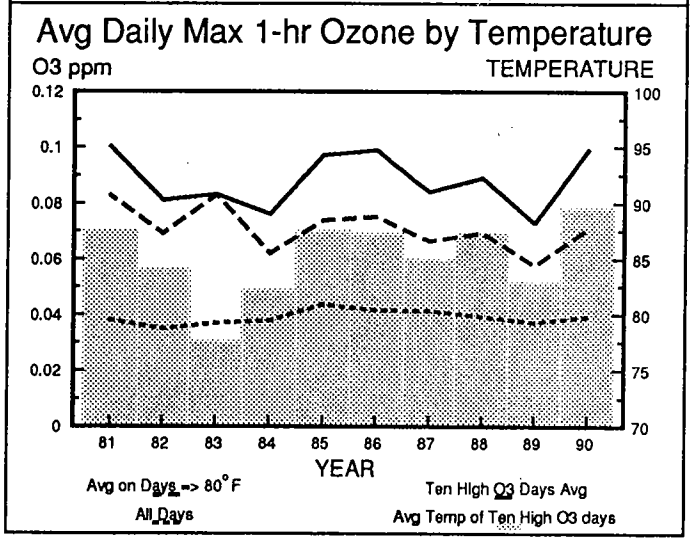
Average CO levels did not show a significant trend for any of the averages. CO averages are 29% higher on the colder days.

Average O_3 levels are also stable - not showing a significant trend even though the 1990 averages are the lowest reported. The highest average O_3 levels for the ten highest O_3 days and for the days with temperatures of 80° F and higher occurred in 1983. The highest O_3 average for all days occurred in 1984. Average daily maximum temperature for the ten highest O_3 days ranged from a low of 76° F in 1990 to a high of 92° F in 1984. The average daily maximum temperature and O_3 levels correlated well on these days. The correlation (-0.82) was highly significant.


LEGEND
Met Station
CO
O_3
NO_2
SO_2
Pb
PM_{10}
trend sites
Counties
Major Roads
4%
%Calm
1-6
7-18
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency







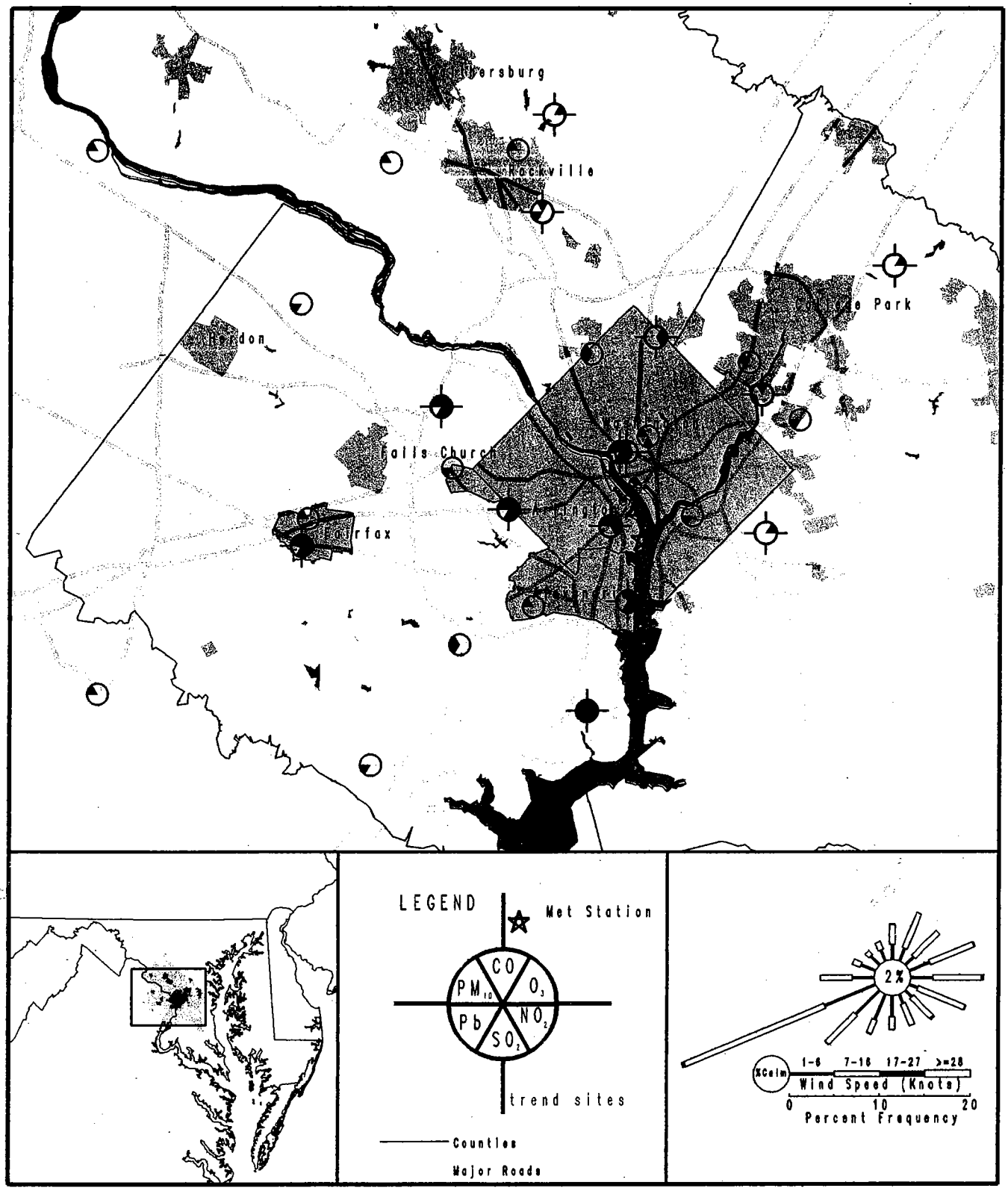
Seattle, WA

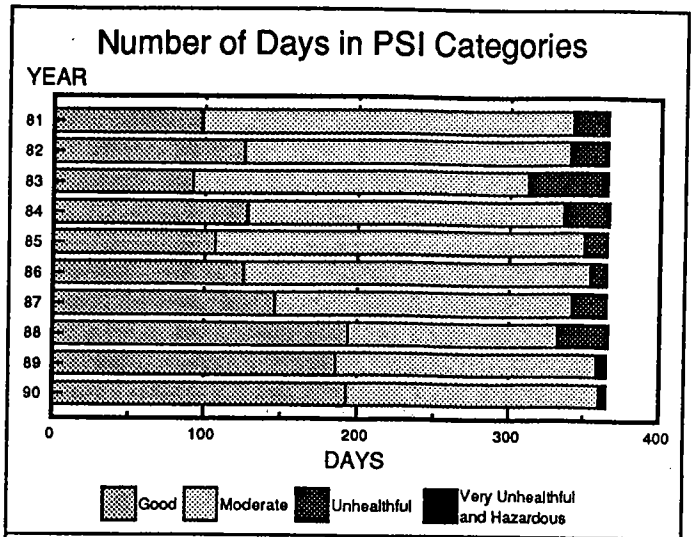
The Seattle PMSA consists of King and Snohomish Counties. Seventy-seven percent of its population lives in King County. The estimated 1987 population was 1.8 million. Twenty-three currently active monitoring sites are shown on the map.

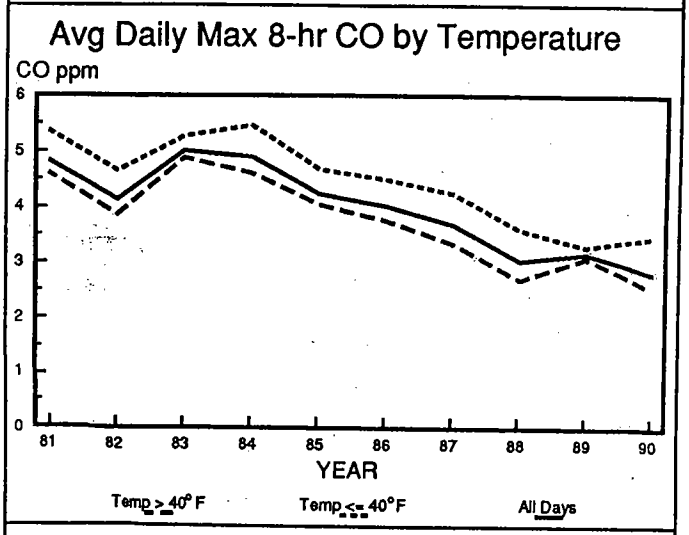
The PSI trend for Seattle is based on 7 sites: 6 for CO and 1 for O_3, all located in King County. There are 2 maximum concentration CO sites and 4 population exposure sites. The O_3 site is a population exposure site. The number of PSI days > 100 are dominated by CO, which accounts for 141 (91%) of these days over the 10-year period. There has been a significant improvement in these days. In 1990, for the first time, CO did not account for any PSI > 100 days at these trend sites. However, one of the maximum concentration CO sites did not report data in 1990. The 2 PSI > 100 days reported in 1990 were from O_3. Seventy-two percent of the unhealthful or worse days occurred in the winter. The 2 very unhealthful days occurred in 1981. CO was responsible for both of these days. No hazardous days were reported.

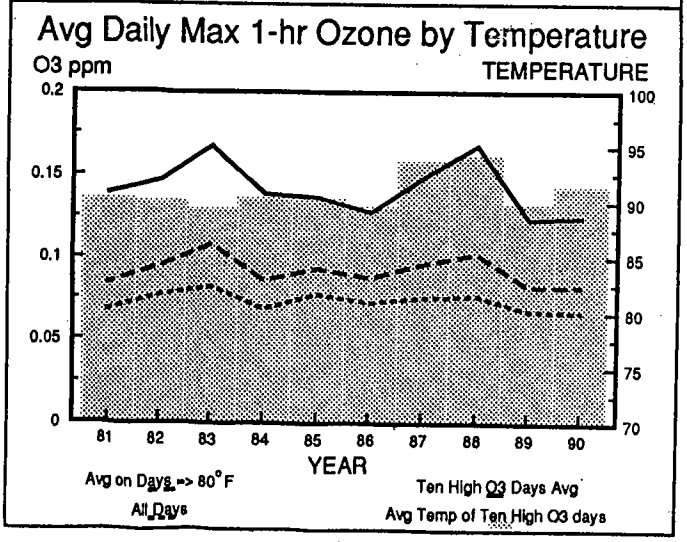
Average CO levels showed a significant decrease over the 10-year period for both temperature categories and for all days. CO levels are 28% higher on the colder days.

Average O_3 levels are stable for the 3 averages presented. However, the 1990 O_3 averages increased along with the average daily maximum temperature on the ten highest days, which was the highest average daily maximum temperature reported (89.5° F). The highest average O_3 levels for the ten highest O_3 days and for days with temperatures of 80° F or higher occurred in 1981; while, the lowest O_3 averages for these categories occurred in 1989. The lowest average daily maximum temperature (78° F) on the ten highest days occurred in 1983. The correlation between average daily maximum temperature and O_3 levels was positive and significant.


Rockville
Falls Church
Fairfax
LEGEND
Met Station
CO
O3
NO2
SO2
Pb
PM10
trend sites
Counties
Major Roads
2%
Calm
1-6
7-16
17-27
>=28
Wind Speed (Knots)
0
10
20
Percent Frequency







Washington, DC-MD-VA

The Washington MSA consists of 10 counties, the District of Columbia (DC) and 5 independent cities. The principal population centers are DC, Fairfax County in Virginia and Montgomery and Prince Georges Counties in Maryland. The estimated 1988 population was 3.6 million. Its size and location as a part of the eastern seaboard megalopolis contribute to the area's air pollution potential. A total of thirty-two currently active monitoring sites are operating in the PMSA - 29 of these sites are located in that portion of the PMSA shown on the map.

The Washington PSI trend is based on data from 14 sites: 3 CO, 4 O_3 and 7 where both pollutants were monitored. Both CO and O_3 had 1 maximum concentration site reporting data. The maximum concentration O_3 site is located in Prince Georges County, Maryland, while the maximum concentration site for CO is located in DC. The number of unhealthful or worse days varied from a high of 53 in 1983 to a low of 5 in 1990. The number of days attributed to CO declined significantly, averaging 13 days for the first 4 years and 2 for the last 4 years. Ozone accounted for all but 1 of the 34 unhealthful or worse days in the very hot summer of 1988. In the 10-year period, 8 days fell in the very unhealthful category; the last occurred in 1987. No hazardous days were reported.

Average CO levels showed a significant decline over the ten years for all 3 averages presented. CO levels were 19% higher on the colder days. Average O_3 levels show no clear long-term trend over the 10 years for any of the averages. Once again the effect of the very hot and dry summers of 1983 and 1988 can be seen in average O_3 concentrations. The average daily maximum temperature for the ten highest O_3 days varied from a low of 89° F in 1983 to a high of 94° F in 1987 and 1988. The correlation was not significant between the temperature and O_3 levels on the ten highest days.

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16. ABSTRACT

This report presents national and regional trends in air quality from 1981 through 1990 for particulate matter, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone and lead. Air quality trends are also presented for 15 metropolitan areas. Both national and regional trends in each of these pollutants are examined. National air quality trends are also presented for both the National Air Monitoring Sites (NAMS) and other site categories. In addition to ambient air quality, trends are also presented for annual nationwide emissions. These emissions are estimated using the best available engineering calculations; the ambient levels presented are averages of direct measurements.

This report also includes a section, Air Quality Levels in Metropolitan Statistical Areas (MSAs). Its purpose is to provide interested members of the air pollution control community, the private sector and the general public with greatly simplified air pollution information. Air quality statistics are presented for each of the pollutants for all MSAs with data in 1990.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Trends Emission Trends Carbon Monoxide Nitrogen Dioxide Ozone Sulfur Dioxide Total Suspended Particulates Particulate Matter Lead Air Pollution Air Quality Standards National Air Monitoring Stations (NAMS)		

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
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	20. SECURITY CLASS *(This page)*	22. PRICE

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